Project Manual for:

Plymouth South High School

Plymouth, Massachusetts

100% Construction Documents Specification

Prepared by:

Ai3 Architects, LLC
526 Boston Post Road
Wayland, MA 01778

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FIRE SUPPRESSION

(Filed Sub-Bid Required)

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SECTION 21 00 00
FIRE SUPPRESSION
(Filed Sub-Bid Required)

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. The BIDDING REQUIREMENTS, CONTRACT FORMS, and CONTRACT CONDITIONS as listed in the Table of Contents, and applicable parts of Division 1 - GENERAL REQUIREMENTS shall be included in, and made a part of this Section.

B. Work of this Section requires Filed Sub-Bids and is governed by the provisions of the Massachusetts General Laws (MGL), Public Bidding Law - Chapter 149, Sections 44A to 44J inclusive, as amended, and applicable Sections of the MGL, Public Contract Law - Chapter 30.

C. The work to be completed by the Filed Subcontractor for the work of this Section is shown on the following listed Drawings:

Civil Drawings: C0.1 through C6.7 included.

Site Work Drawings: L1.0 through L 3.10 inclusive.
Architectural Drawings: A1.10 through A12.19 inclusive.
Food Service Drawings: K1.0 through K3.2 inclusive
Structural Drawings: S0.01 through S7.01 inclusive.
Plumbing Drawings: P1.11 through P2.7 inclusive.
Fire Protection Drawings: FP1.11 through FP1.34 inclusive.
Mechanical Drawings: M0.1 through M4.1 inclusive.
Electrical Drawings: ES.1 through E2.16 inclusive.
Telecommunications Drawings: T1.10 through T2.11 inclusive

1. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section. The listing of Contract Drawings above does not limit Filed Subcontractor's responsibility to determine full extent of work of this Section by all Drawings listed in the Drawing List on the Drawing Title Sheet, as modified by Addenda.
2. Refer to Section 01 23 00 - ALTERNATES, for alternates that may affect the scope of Work of this Section.

D. Sub-Bids for work under this Section shall be for the complete work and shall be filed in a sealed envelope with the Awarding Authority at a time and place as stipulated in INVITATION TO BID and INSTRUCTIONS TO BIDDERS.

1. The following shall appear on the upper left hand corner of the envelope:

NAME OF SUB-BIDDER: _____
SUB-BID FOR TRADE: TITLE.

2. Each Sub-Bid submittal for work under this Section shall be on forms furnished by Awarding Authority, as bound herein, accompanied with the required bid deposit in compliance with MGL c149, Section 44B in the amount of 5 percent of Filed Sub-Bid.

1.2 GENERAL REFERENCES

A. Bidding Requirements, Contract Forms, General Contract for Construction Services and Division 1, General Requirements are hereby made a part of this Section.

B. Examine all Drawings and all other sections of the specifications for requirements therein affecting the work of this section.

1.3 SCOPE OF WORK

A. Work in this Section includes all labor, materials, equipment and services necessary to furnish completely and install all FIRE SUPPRESSION SYSTEMS, as indicated on the Drawings and specified herein and, in general, as follows:
1. Complete combined wet pipe standpipe/sprinkler systems covering all areas of the building, complete with standpipes with hose valves, all fire water service, fire hydrants and valves as indicated on drawings C4.3 & C4.4
2. Monitor, pressure and flow switches.
3. Valve tags, valve charts, nameplates, and pipe identification and record drawings.
4. Testing and guarantees.
5. All hangers, inserts, sleeves, anchors, guides, strainers, gauges, thermometers, plus all related accessories required for a complete installation for each system, as specified herein and/or indicated on the drawings.
6. All operating and maintenance manuals, certification letters and Certificates of Approval.
7. All supplementary steel for piping and equipment supports.
8. Working drawings of the actual fire suppression system installation, hydraulic calculations and performing of flow tests from existing fire pump.
9. Tamper switches to be installed with supervisory signal.
10. Supervised low pressure alarm on city side of the backflow preventer, trouble signal upon activation.
11. Low pressure alarm located on system side of wet system, alarm signal upon activation flow test, time to alarm 60 seconds or less desired.
12. Hydraulic charts & signage on all valves, drains, inspector's test.
13. Valves located above suspended ceiling shall be installed within 2 feet of the ceiling tiles for accessibility by 6 foot step later.
14. FDC's shall be 6 inch Storz type with strainer screen of 1/4inch mesh and 30 degree elbow downward, no less than 24 inches from finish grade.
15. Full fire pump test in accordance with provisions in NFPA-25, 2011 Edition with complete report as referenced in MSBC Chapter 9 and MA 527 CMR Fire Prevention Regulations.

B. Items to be furnished only: Furnish the following items for installation by the designated Sections:
1. Access Panels
   a. Access panels for access to fire suppression equipment shall be furnished under this Section for installation by the General Contractor or appropriate Subcontractor.

C. The Fire Suppression Contractor shall be responsible for all cutting related to the work of this Section except in finished surfaces. Patching is the responsibility of the trade effected.

1. For coordination of cutting and patching, refer to Section 013100 PROJECT MANAGEMENT AND COORDINATION.

2. For cutting and patching specifications, refer to Section 017300, EXECUTION.

D. The work of this Section is shown on Drawings numbered FP1.11, FP1.12, FP1.13, FP1.14, FP1.15, FP1.16, FP1.21, FP1.22, FP1.23, FP1.24, FP1.25, FP1.26, FP1.31, FP1.32, FP1.33 and FP1.34.

1.4 WORK NOT INCLUDED

A. The following related work shall be performed by the designated trades and under the listed SECTION:
1. Wiring of equipment requiring power connections and furnished by the Fire Suppression Contractor and starting devices for all motors incidental to the Fire Suppression Systems shall be furnished and installed by the Electrical Sub Contractor: Section 260000.
2. Painting of piping, fittings, coverings, hangers, supports and all equipment not specifically specified to be painted by the Painting Contractor: Section 099100
3. Electricity and water for all tests and temporary operation of Fire Suppression Systems: GENERAL REQUIREMENTS.

1.5 INTENT

A. All work shall be in accordance with the arrangement, details and locations, as indicated on the Contract Drawings, Reference Drawings and any supplemental addenda, bulletins or drawings issued by the Architect. Layouts are diagrammatic and final arrangement of equipment shall suit field conditions. Install all necessary fittings and equipment offsets required to meet job conditions. The Drawings are not intended to be scaled, but shall be followed with sufficient accuracy to coordinate with other work and structural limitations. Work installed in a manner contrary to that shown on the Drawings, or interfering with the work of another trade, shall be removed and reinstalled when so directed by the Architect. Discrepancies and questionable points shall be immediately reported to the Architect for clarification.

1.6 CODES, REGULATIONS AND STANDARDS

A. All work shall be installed in conformance to the governing Codes, Regulations and Ordinances. It shall be the responsibility of this Contractor to familiarize himself with all governing Codes, Regulations and ordinances and report any non-compliance of the Plans and Specifications to the Architect, prior to entering into a contract. All the above requirements shall take precedence over the Plans and Specifications. These requirements are minimum criteria and no reductions permitted by Code will be allowed without written permission of the Architect.

B. All workmanship, methods and materials shall meet the highest standards of the trade and, in general, shall conform to the standards of the following associations:

American National Standards Institute (ANSI)
American Society of Mechanical Engineers (ASME)
National Board of Fire Underwriters (NBFU)
National Fire Protection Association (NFPA) 2013 Edition
National Electrical Manufacturers Association (NEMA)
Occupational Safety and Health Act (OSHA)

Underwriters' Laboratories (U.L.)
American Society of Testing Materials (ASTM)
Massachusetts State Building Code, NFPA 1
Regulations and Ordinances of the Town of Plymouth.

1.7 DRAWINGS AND CONFLICTS IN THE WORK

A. The Drawings and Specifications are intended to be complementary. Any materials shown or specified in one, but not in the other, reasonably implied and usually included under good industry practice and/or required by applicable Codes and Regulations for the proper and safe completion and operation of the work described herein, shall be furnished and installed by this Contractor at no additional cost to the Owner. Drawings show general arrangement of equipment and are not intended to indicate the exact dimensions of runs.

1.8 EXCHANGE OF INFORMATION AND COORDINATION

A. All systems and equipment covered by this Section of the Specifications shall not be installed in congested and problem areas without first coordinating the installation of same with the other trades and the General Contractor. This Contractor shall, at his own expense, relocate all equipment installed in congested or problem areas should they interfere with the proper installation of the equipment to be installed by other trades and by the General Contractor.

B. Particular attention shall be directed to the coordination of Systems with all equipment of other trades installed in the ceiling areas. Coordinate, with the other trades, the elevations of all equipment in ceiling areas to insure adequate space for the installation of fixtures before said equipment is installed.

C. Furnish to the General Contractor and all other Contractors all information relative to the portion of the installation specified in this Section that will affect them, sufficiently in advance, so that they may plan their work and installations accordingly.

D. In the case of failure on the part of this Contractor to give proper information, as indicated above, sufficiently in advance, this Contractor will pay for all back charges incurred by the General Contractor and other Contractors for the modification and/or relocation of any portion of the work already performed by them in conjunction with this Contract due to this Contractor's delay or for having given incorrect information.

E. Obtain from the other trades, all information relative to the work covered by this Section of the Specifications, which this Contractor is to execute in conjunction with the installation of their respective equipment.

F. In the event that conflicts, if any, cannot be settled rapidly and amicably between the affected trades with work proceeding in a workmanlike manner, then the Architect shall decide which work is to be relocated and his judgment shall be final and binding.

G. Coordinate connection to existing fire water system with Plymouth Public Schools facilities personnel.

H. The contractor shall contact “Dig safe” at 1-888-dig-Safe to verify locations of existing underground utilities in areas of proposed excavation prior to commencing any excavation efforts.

1.9 WORKMANSHIP

A. The entire work provided in this Specification shall be constructed and finished, in every respect, in a workmanlike and substantial manner. It is not intended that the Drawings show every detail, but this Contractor shall furnish and install all such parts as may be necessary to complete the work in accordance with the best trade practice and to the satisfaction of the Architect and the Owner. The Owner shall have the right to reject any part of the work in case the workmanship is not of satisfactory quality and this Contractor shall replace same with acceptable work at his own expense.

1.10 SITE INVESTIGATION

A. It shall be the responsibility of the Bidders to acquaint themselves with the available information, before submitting their bid. Bidders must visit the site and acquaint themselves with the existing conditions and shall study all Architectural, Structural, Mechanical and Electrical, Civil Drawings, as well as the Specifications. The Bidders shall fully inform themselves of all local and state Code requirements. Extra compensation will not be given for obvious conflictions apparent at the time of the start of the project. Contractor to visit the existing Fire Pump house and walk site for new fire mail installation.

1.11 TAXES AND INSURANCE

A. This Contractor shall include in his bid, applicable federal, state and local taxes and the premiums of the insurance required by the General Conditions of the Contract. This Project is exempt from Massachusetts State Sales Tax. Tax exemption number will be given to the successful bidder.

1.12 PERMITS AND INSPECTIONS

A. This Contractor shall obtain all the permits required for this Section of the work. He shall also obtain all the inspections and tests required. Defects discovered in work, materials and/or equipment shall be replaced at no cost to the Owner, and the inspection and test shall be repeated. When work is completed, this Contractor shall furnish a Certificate of Inspection and Approval, to the Owner, before final payment of the Contract will be allowed. Permits to be secured through the Town of Plymouth.

B. Refer to Instructions to Bidders and General Conditions Contract for Construction Services.

1.13 CONTRACT COST BREAKDOWN

A. At the start of construction, submit a breakdown of material and labor costs to aid the Architect in determining the value of the work installed, as the job progresses. The cost breakdown shall itemize categories of materials or portions of systems, as may be the case, to place a value on the work as it is installed.

B. No requisitions will be paid until after the breakdown is delivered to the Architect.

1.14 GUARANTEE

A. Unless otherwise noted, all materials, items of equipment and workmanship furnished under this Section shall carry the standard warranty against all defects in material and workmanship for a period of not less than <u>two (2) year from the date of</u>

final acceptance of the work. Any fault due to defective or improper material or workmanship which may develop within that period, shall be made good, forthwith, by and at the expense of this Contractor, including all other damage done to areas, materials and other systems resulting from this failure.

B. This Contractor shall guarantee that all elements of the Systems are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated.

C. Upon receipt of notice from the Owner of failure of any part of the Systems during the guarantee period, the affected part or parts shall be promptly replaced by this Contractor, at no charge to the Owner.

D. This Contractor shall furnish, before the final payment is made, a written guarantee covering the above requirements.

1.15 MATERIALS

A. Materials shall be the best of their respective kinds and in full accord with the most modern mechanical construction. All materials shall be new.

B. All materials necessary to make the installation complete in every detail shall be furnished and installed under this Contract, whether or not specifically shown on the Drawings or specified herein.

C. It is the intent of the Specifications that one manufacturer be selected, not a combination, for any particular classification of materials.

D. Where materials, equipment, apparatus or other products are specified by manufacturer, brand name, type or catalog number, such designation is to establish the standard of desired quality and style and shall be the basis of the bid.

1.16 MATERIALS AND EQUIPMENT HANDLING

A. This Contractor shall do all handling of his materials and equipment and the resulting cleanup, at his expense, in a safe and satisfactory manner. Special attention shall be paid to the protection of life and property and the equipment or apparatus handled, and any corresponding damages shall be replaced, repaired or paid for by this Contractor, reviewed by the Architect. This Contractor shall provide all rigging, hoisting and staging required to complete the work of this Section, unless specifically noted otherwise.

1.17 MAINTENANCE AND PROTECTION OF MATERIALS

A. This Contractor shall be responsible for the maintenance and protection, from loss or damage of all causes, of all equipment, materials and tools supplied by him and stored or installed on the job site, until final acceptance of the project by the Owner.

B. This Contractor shall store his materials and equipment in the location designated by the Owner and maintain the storage area in a safe condition.

C. This Contractor shall clean, patch and repair any material and finishes of the building or its contents damaged during the execution of this Contract.

1.18 SHOP DRAWINGS AND MATERIAL SCHEDULE

A. Submit complete Shop Drawings in accordance with provisions of the General Conditions and of the Supplementary General Conditions.

B. Within 30 days after the date of Notice to Proceed and before purchasing any materials or equipment, submit to the Architect for approval, a complete list of the names of manufacturers of all equipment proposed to fulfill the work of this Section. After the list has been processed by the Architect, submit complete Shop Drawings of all equipment and materials. Do not order any material or equipment until approval has been obtained from the Architect.

C. The approval of equipment and materials does not relieve this Contractor from the responsibility of Shop Drawings errors in details, sizes, quantities and dimensions which deviate from the Specifications, Contract Drawings and/or job conditions as they exist.

D. If apparatus or materials are substituted by this Contractor for those specified, and such substitution necessitates changes in any mechanical or electrical equipment, or alteration to connections, piping, supports, or construction, same shall be provided. This Contractor is to assume the cost and entire responsibility thereof. The Architect's permission to make such a substitution shall not relieve this Contractor from full responsibility for the work.

E. Changes to work already performed, made necessary by delays in Shop Drawing approvals, and are the responsibility of this Contractor.

1.19 RECORD DRAWINGS

A. The Architect will provide two (2) sets of black or blue line on white drawings to the General Contractor for the purpose of maintaining record drawings, one set of which shall be maintained at the site and on which, at all times, shall be accurately, clearly and completely show the actual installation of all work of this SECTION. At the completion of the contract, this Contractor shall submit to the General Contractor a complete set of record drawings showing all "As Built" conditions. After checking the aforementioned drawings, the General Contractor shall certify that they are complete and correct and shall submit the record drawings to the Architect. The Architect may have his Consulting Engineers review the drawings to determine if the installations, as shown thereon, are complete and accurate. After receiving verification that the Record Drawings are complete and accurate, this Contractor shall submit new mylar reproducible copies of the final Record Drawings to the Architect. Each drawing shall be marked "RECORD DRAWING" and dated. Availability of record drawings shall be prerequisite to scheduling a final inspection of this contract and said drawings and original contract documents will be used in checking completion of the work. Non-availability of record drawings or inaccuracies therein may be grounds for cancellation and postponement of any scheduled inspection by the Owner and shall be a condition precedent to final payment until such time as the discrepancy has been corrected. This contractor shall refer to Section 017800 for additional contract requirements to be performed for Record Drawings.

B. The record drawings required to be furnished under the terms of this Contract are:

Section	Reference Section	Drawings Required
FIRE SUPPRESSION	21 00 00	FP1.11, FP1.12, FP1.13, FP1.14, FP1.15, FP1.16, FP1.21, FP1.22, FP1.23, FP1.24, FP1.25, FP1.26, FP1.31, FP1.32, FP1.33 and FP1.34,

1.20 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

A. Provide operating instructions to the Owner's designated representative, with respect to operating and maintenance procedures, for all equipment and systems installed. The cost of up to eight (8) hours of instruction shall be included in the Contract Price. This contractor shall refer to Section 017800 for additional contract requirements to be performed for Operating Instruction and Maintenance Manuals.

B. At the completion of the project, turn over to the Architect, three (3) complete manuals containing the following:
1. Complete shop drawings of all equipment.
2. Operation description of all Systems.
3. Names, addresses and telephone numbers of all suppliers of the products, materials, equipment and Systems.
4. Guarantees on all products, materials and equipment.
5. Preventive maintenance instructions for all Systems.
6. Spare parts list of all System components.
7. Complete report of the existing fire pump test and equipment.

C. Each manual shall be typewritten and bound under one (1) hard cover and will be reviewed by the Architect. The manuals shall be clearly and permanently identified on the cover with the name of the project.

D. Upon completion of the instructions, this Contractor shall obtain a letter of acceptance of the instructions as being complete from the Owner. Submit a copy of said letter to the Architect.

1.21 COORDINATION DRAWINGS

A. This Contractor shall be responsible to develop and furnish all required information on the coordination drawings required under DIVISION 01 of the Specifications. Contractor shall coordinate the elevations and locations of all his systems with the work of all other trades.

1.22 CLEANING OF SYSTEMS

A. Before the Systems are accepted, all equipment shall be thoroughly cleaned, so that no dirt, dust or other foreign matter will be deposited and be detrimental to the operation of the Systems.

B. After the installation is complete, equipment with factory finished surfaces shall be cleaned and damaged or scratched spots shall be touched up with the same type and color paint applied at the factory.

C. All equipment that is to receive finish paint by the Painting Contractor, shall be cleaned by this Contractor and left ready to have surfaces prepared to receive paint.

1.23 RUBBISH REMOVAL

A. At the completion of the work, or when ordered by the General Contractor or the Architect, this Contractor shall remove from the property, all the rubbish or waste material belonging to him. Keep the job site free from accumulation of waste material and rubbish; premises must be maintained in a clean condition.

1.24 TEMPORARY STRUCTURES

A. This Contractor shall provide, on the premises and where directed by the Architect, shall maintain in good condition, and shall remove when directed, suitable and substantial watertight sheds in which he shall store all his materials and equipment.

1.25 TEMPORARY SERVICES

A. All water, electricity, fire protection and sanitary facilities required for safe and efficient construction during normal working hours shall be furnished in accordance with the General Requirements.

1.26 TESTS

A. Furnish all labor, materials, instruments, supplies and services and bear all cost for the accomplishment of the tests herein specified. Correct all defects appearing under test, repeat the tests until no defects are disclosed and leave the equipment clean and ready for use.

B. Perform any tests, other than herein specified, which may be required by legal Authorities or by Agencies to whose requirements this work is to conform.

C. Dispose of test water and wastes after tests are complete, in a manner satisfactory to the Architect and in accordance with governing regulations.

1.27 EQUIPMENT ACCESS REQUIREMENTS

A. All work shall be installed so that all parts requiring inspection, operation, maintenance and repair are readily accessible. Minor deviations from the Drawings may be made to accomplish this, but changes of magnitude shall not be made prior to written approval from the Architect.

B. Furnish access panels in walls and ceilings at locations indicated on the Drawings, or to permit access for adjustment, removal and the replacement and servicing of all equipment, and all other items requiring maintenance and adjustments. Access panels shall be installed by the General Contractor.

C. Coordinate the exact location of access panels in all finished spaces with the Architect.

1.28 MOTOR CHARACTERISTICS

A. Unless otherwise indicated, motors for equipment specified under this Section shall be furnished and installed by the Fire Protection Contractor and shall be as follows:
   1. Motors 1/3 HP and smaller shall be wound for 120 volts, single phase, 60 cycle AC service.

B. Unless otherwise specified, all motor starters shall be furnished and installed by the Electrical Subcontractor.

1.29 WIRING DIAGRAMS

A. This Contractor shall furnish wiring diagrams for all equipment furnished under this Section for which wiring is to be installed by the Electrical Subcontractor.

1.30 PROCEDURE FOR TESTING

A. Partial tests shall be made during the progress of the work.

B. All labor, materials, instruments, devices and power required for testing shall be furnished by this Contractor. All tests shall be performed in the presence and to the satisfaction of the Architect and such other parties as may have legal jurisdiction.

C. Repair, or if directed by the Architect, replace all defective work with new work without extra charge to the Contract. Repeat tests as directed until all work is proven to meet the requirements specified herein.

D. Restore to its finished condition any work or materials disturbed by tests.

E. This Contractor shall be responsible for removing all temporary piping connections required for tests and dispose of test water and wastes after tests in a manner satisfactory to the Architect.

F. This Contractor shall make hydrostatic, pneumatic and operational tests on all fire protection equipment in accordance with standards of the National Board of Fire Underwriters and by the NFPA.

G. Fire Protection Systems:
   1. Upon completion of each phase of the fire protection system installation, this Contractor shall inspect and test the systems in the presence of the Owner's representative and the Fire Inspector.
   2. The complete testing procedure for the system shall be in accordance with the requirements stated in the National Fire Protection Association's respective pamphlet for each system, but not less than the procedures specified herein.
   3. In general, the Fire Protection Systems shall be tested with water to a hydrostatic pressure of 200 pounds per square inch. This pressure shall be maintained for a minimum of four (4) hours or until the system has been inspected for leaks or defects. If any leaks or defects are detected, they shall be remedied in an approved manner and the System shall be retested in the manner specified herein.
   4. This Contractor shall secure all Certificates of Approval from all agencies. Each Certificate shall be delivered to the Architect before final acceptance.

H. This Contractor shall be responsible to install, instruct, test, document and perform all other services necessary pertaining to the installation of all fire water mains, fire hydrants and related components. provided under this section so that he can certify that said installation is in accordance with all NFPA requirements and shall provide a fully executed "Contractor's Material and Test Certificate for Underground Piping" in NFPA 14, 2013 edition.

PART 2 PRODUCTS

2.1 INSTALLATION REQUIREMENTS

A. This Contractor shall comply with all the rules, Codes, ordinances, regulations and requirements of all legally constituted authorities having jurisdiction over the whole or any part of the work herein specified. Regulations supplement this Specification and shall take precedence in any case of conflict.

B. All equipment and materials furnished in connection with the installation shall be new and furnished in accordance with the requirements of the Standards of the NFPA and they shall be of the best grade and quality of their respective kinds, free from natural, manufacturing or construction flaws, defects or irregularities and finish, fittings and workmanship shall be equal to the highest commercial grade.

C. Castings of all metals of all kinds shall be clean, smooth, close grained, of uniform thickness and free from all defects such as sand holes, blisters or cracks.

D. Before the installation will be accepted, the Fire Protection Contractor shall have every portion of his work in first-class working condition.

E. Where installing any of the apparatus herein called for, sufficient clearance shall be allowed to permit the removal and replacing of parts that may require future removal for repairs and replacement.

F. Exposed piping shall be installed as tight as practical to structural members.

G. Piping shall be installed neatly and square to all surfaces. Horizontal sidewall sprinklers shall be installed as tight to beams and ceilings as the sprinkler listing will allow with reference to the existence of beams.

2.2 ACCESS PANELS

A. Furnish access panels for installation by the General Contractor, in walls and non-accessible ceilings, at locations to permit access for adjustment, removal and replacement of all equipment, such as valves, drains, and all other items requiring maintenance and adjustment.

B. All access panels shall be located in closets, storage rooms and/or other non-public areas, in a workmanlike manner, positioned so that the junction can be easily reached, and the size shall be sufficient for this purpose (minimum 16" x 16"). When access panels are required in corridors or other public areas, they shall be located as directed by the Architect.

C. Panels shall be of the types specified in Section 083100 and shall be set square and flush in cooperation with the Subcontractors for other Sections of the Specifications. Particular attention shall be exercised in the selection of doors for masonry walls in order that frame sizes used will match the courses of concrete masonry units.

D. Access panels Shop Drawings shall be submitted to the Architect for approval.

2.3 PIPE AND FITTINGS

A. All piping inside the building for the fire protection systems 2-1/2 inches and smaller in size, unless otherwise specified, shall be Schedule 40 black steel pipe with threaded ends conforming to ASTM Standard A135, latest amendment, approved for use in Fire Protection Systems. All piping inside the building, three inches (3") and larger in size, unless otherwise noted, shall be Schedule 10 black steel pipe with rolled groove ends, approved for use in Fire Protection Systems.

B. Fittings for the systems shall be cast iron, unless otherwise specified. Cast iron fittings shall be extra heavy pattern for pipe sized larger than two inches (2"). Malleable iron fittings of standard weight pattern will be acceptable in sizes up to six inches (6"). U.L. approved and F.M. listed groove fittings will be allowed. All fittings shall be approved by Underwriters Laboratories for use in sprinkler systems and shall be designed and guaranteed for a working pressure of not less than 175 psi cold water pressure.

C. All close and shoulder nipples shall be of corresponding materials as the pipe and shall be extra heavy pattern.

D. All pipe shall be run true to line and grade and, in general, parallel to walls and ceilings. All open ends of the pipe lines and equipment shall be properly capped and plugged during the installation in order to keep dirt or foreign materials out of the system. All work shall be performed in a practical manner and according to the highest standards of workmanship.

E. All threaded pipes shall have full tapered threads with ends reamed out after threading and cutting.

F. The interior of all pipes and fittings shall be cleaned before assembling. All pipe threads (not fittings) shall have a thorough application of approved pipe joint cement before assembling. Any leaky joints shall be remade, as caulking will not be permitted. All pipe shall be pitched. Means shall be provided to completely drain the entire system. Capped flushing connections shall be provided at the ends of all cross mains.

G. Underground pipe shall be ductile iron cement-lined, Class 52, and shall conform to AWWA specifications C150 and C151, latest revision. Duct iron pipe shall have push-on type joints with the exception that mechanical joints shall be used at all fittings and along straight pipe sections where mechanical joints restraint is required. All pipe shall have a bituminous seal coating on all exterior surfaces. Joints shall be push-on and mechanical type joints for pipe as specified and shall conform to AWWA C111, latest revision. Gasket material for jointing requirements shall be styrene butadiene (SBR).

2.4 VALVES

A. All valves shall be of the O.S. & Y. type, of approved extra heavy flanged pattern and be designed and guaranteed for a minimum working pressure of 175 psi. All shut-off valves shall be located in conveniently accessible positions. Valves controlling the water supply to each system shall have an approved sign attached to the yoke indicating the purpose of the valve.

B. Check valve shall be of approved type for fire protection systems and be designed and guaranteed for a minimum working pressure of 175 psi.

C. Drain valves shall be Underwriters' approved all bronze angle, globe pattern with renewable disc, hose with cap and chain, ample size hand wheel and rated for a working pressure of 175 psi.

2.5 HANGERS, SUPPORTS AND SEISMIC RESTRAINTS

A. All piping shall be supported throughout the building structure by means of approved hangers and supports. Piping shall be supported to maintain required grading and pitching of lines, to prevent vibration and to secure piping in place, and shall be so arranged as to provide for expansion and contraction.

B. Pipe hangers shall be of black malleable iron, heavy petters in two (2) parts bolted together, of a type approved for Fire Protection Systems installation.

C. Hangers shall fit the pipe snugly but leave the pipe sufficient freedom of movement for expansion or contraction. Hangers which permit wide lateral motion of the pipe will not be acceptable.

D. "C" clamps for hangers on pipes will not be permitted unless installed with safety straps.

E. Maximum spacing of hangers on horizontal runs of pipe, having no concentrations of weight, shall be as follows:

SCHEDULE

Hanger Spacing for Various Pipes

Pipe Size (inches)	Spacing (feet)
1	7
1-1/4	10
1-1/2	10
2	10
2-1/2	10
3	12
3-1/2	12
4	10
6	8
8	8

F. Where Codes having jurisdiction require closer spacing, the hanger spacing shall be by Code in lieu of the distance specified herein.

G. Provide hangers at a maximum distance of two feet (2') from all changes in direction (horizontal and vertical) on both sides of concentrated loads independent of the piping.

H. Hangers, in general, for all horizontal piping shall be adjustable clevis type hangers.

I. All vertical drops and run out pipes shall be supported by extension style, split ring type hangers.

J. All horizontal piping shall be suspended from the building by mild steel rod connecting the pipe hanger to inserts, angle brackets and lag screws, by the building construction in accordance with the following table:

Pipe Size (inches)	Rod Diameter (inches)
1 - 3	3/8
3 - 6	1/2
8	3/4

K. Hanger rods for other installation shall be sized in accordance with recommended load capacities of Specification A.S.T.M. Designation A-107, latest amendment.

L. Remove rust from all ferrous hanger equipment (hangers, rods and bolts) and apply one (1) coat of rust inhibiting paint immediately after erection.

M. All piping installed under this Section of the Specifications shall be independently supported from the building structure and not from the piping, ductwork or conduit of other trades. All supplementary steel required to meet requirements specified herein shall be furnished and installed by this Contractor.

N. In areas where support of the pipe by hangers is not possible or feasible, piping shall be supported by an adjustable pipe roll stand with base plate equal to Figure 274, as manufactured by Grinnel Corporation. This installation method shall be done in accordance with the requirements of all pertinent Codes.

O. All supplementary steel throughout the project for this Section of the Specifications, both suspended and floor mounted, shall be furnished and installed by the Fire Protection Contractor and shall be subject to the approval of the Architect.

P. All pipe hangers and equipment supports shall be constructed and installed in accordance with Seismic Zone requirements as outlined in the State Building Code. This Contractor shall submit one (1) copy of shop drawings and calculations detailing seismic hanger restraints to the local Building Authority and Architect, along with a letter of compliance signed by a registered structural engineer confirming that the piping hangers meet state seismic code requirements. Cable provided for seismic systems shall be color coded and pre-stressed. Contractor to coordinate and confirm seismic restraints are required with the structural engineer.

2.6 SLEEVES AND INSERTS

A. This Contractor shall be held responsible for the location of and maintaining in proper position, of sleeves, inserts and anchor bolts supplied and/or set in place by him. In the event that failure to do so require cutting and patching of finished work, it shall be done at this Contractor's expense by the General Contractor.

B. All pipes passing through walls or partitions shall be provided with sleeves having an internal diameter one inch (1") larger than outside diameter of the pipe.

C. Unless otherwise indicated and/or specified herein, all sleeves through masonry floors or interior masonry walls shall be Schedule 40 black steel pipe, set flush with finished wall or set one inch (1") above finished floor surfaces, or as indicated on the architectural drawings. Sleeves in stairwells shall be set flush with finish floor.

D. Sleeves through interior non-masonry partitions shall be 22 gauge galvanized sheet steel, set flush with finished surfaces of the partitions.

E. Sleeves through interior walls adjacent to all building expansion joints shall be two (2) pipe size diameters larger than diameter of pipe.

F. This contractor shall be responsible to review all firestopping of all piping and related components for completeness. All firestopping materials and installation will be by the General Contractor under Section 07 84 00.

2.7 ESCUTCHEONS

A. Escutcheons shall be installed around all exposed bare pipe. Escutcheons shall be of sufficient outside diameters to cover the sleeve opening and shall fit snugly around the bare pipe.

B. Escutcheons shall be cast brass, grey primed finish and provided with a set-screw to properly hold escutcheons in place.

2.8 SPRINKLER HEADS

A. All sprinkler heads shall be quick response type, of 1/2 inch nominal orifice size. Heads shall be listed by Underwriters' Laboratories, Inc. and approved by Factory Mutual. All heads shall be manufactured by a single manufacturer.

B. All heads shall have a temperature rating of 165°F unless the distance from a heat source or location of head warrants, by Code, a head of another degree rating.

C. The following sprinkler heads shall be installed in the areas outlined:
- All upright sprinkler heads in unfinished spaces shall be of brass, with deflectors and fusible links.
- All pendant sprinkler heads, unless noted or designated otherwise, shall be concealed type heads having a ceiling plate of a color to match that of the ceiling it is mounted in. Heads in unheated spaces shall be of the dry pendant type with a maximum length of 36".
- All sidewall heads in heated areas shall be chrome-plated units with sidewall deflectors and fusible links. Sidewall heads serving unheated areas shall have shafts a minimum of 18" in length.
- All sprinkler heads in shower areas shall be wax coated.
- All sprinkler heads in the Gymnasium shall have protective guards on them.
- All sprinkler heads in rooms with black ceilings shall have black sprinkler heads.

2.9 SPARE SPRINKLER HEADS AND CABINETS

A. The Fire Protection Contractor shall furnish and install, where directed by the Architect, a metal cabinet containing spare sprinkler heads and wrenches.

B. The cabinet shall have shelves for storing the spare heads in an orderly manner. The shelf spaces shall be subdivided to segregate the sprinkler heads of each type and clearly identify them with approved markings. The cabinets shall have proper arrangement for hanging the wrenches.

C. Spare sprinkler heads shall be provided in numbers, by NFPA Pamphlet #13, corresponding to the types and temperature ratings of those installed in the premises (6 minimum of each type).

D. Wrenches shall be provided in a number so that there will always be a minimum of two (2) wrenches of each type required to remove any sprinkler head on the premises.

2.10 ALARM CHECK VALVE

A. Alarm check valve shall be approved type for a wet pipe sprinkler system complete with retarding chamber, water operating gong, drain valve, pressure gauges and other required trimmings. Valve shall be equal to Globe Model H-1 for variable pressure vertical installation, sizes as indicated on the drawings, with H-1 trim package, with Globe Model "F" Water Motor and Gong. Electric water gong shall be located on outside of building with head and identification tag.

2.11 FIRE VALVE CABINETS

A. This Contractor shall furnish and install fire valve cabinets complete with all related accessories where shown on the drawings. All cabinets in fire-rated walls shall be fire-rated. Cabinets shall be as follows:

Type "A" - A recessed steel cabinet, equal to Potter-Roemer, Inc. Figure 1880 with door style of Suffix "A" and 2-1/2" valve assembly. Assembly shall include a Potter-Roemer, Inc. 2-1/2" rough brass, 300 lb., U.L. pressure-restricting angle valve No. 4085C. Valve,

All hose valve connections shall face outward at approximately a 45 degree angle to permit easy connection of fire hoses.

2.12 FIRE DEPARTMENT CONNECTIONS

A. Fire department connections shall be Underwriters' Laboratories and NFPA approved units with a “Storz” type connection. Units shall be manufactured of heavy bronze complete with bronze caps, plugs and chains. Provide identification plate of cast brass with the words "AUTO. SPKR. – STANDPIPE” in raised lettering.

2.13 DRAINS AND TEST CONNECTIONS

A. Drains and test connections shall be provided in the systems by all governing Codes, regulations and ordinances.

B. Drains shall be provided at low point in piping, at base of risers, and wherever necessary to insure that all portions of the piping may be completely drained.

C. Test connections shall consist of drain piping with a one inch (1") shutoff valve (O.S. & Y.) type, piped outdoors to a safe place of discharge. Pipe through outside wall shall be galvanized steel pipe with sleeve caulked watertight and plugged with a brass plug.

2.14 FIRE PROTECTION ALARMS

A. O.S. & Y. valve monitor switches and sprinkler system's flow and pressure sensors shall be furnished and installed by the Fire Protection Contractor and wired by the Electrical Subcontractor. The Fire Protection Contractor shall coordinate with the Electrical Subcontractor on this portion of the system. Monitor switches shall be installed on all O.S. & Y. valves and shall be equal to Notifier OSY2 and be fitted with 2-SPDT switches. Flow switches shall be installed as indicated on the drawings and shall be equal to Notifier WFD 10/40 with adjustable delay.

2.15 SYSTEM DIAGRAM

A. At the completion of the work, next to the alarm riser, provide a small scale plan of each floor of the building indicating zones, with locations of all control valves, low point drains and inspector's tests. Plans shall be 1/32" = 1'-0" in scale neatly drawn and color-coded to indicate the portion of the building protected by each system, framed under glass and permanently mounted on the wall adjacent to the header.

PART 3 EXECUTION

3.1 OPERATION AND START-UP

A. The Fire Protection Contractor shall furnish all labor, materials and equipment necessary to place the equipment into operation and then start and operate all systems to demonstrate the fitness of the installation.

B. Prior to start-up, the Fire Protection Contractor shall check all equipment for rotation, check belts for tightness, provide lubrication, clean all equipment, perform pressure tests and make all other adjustments necessary for start-up.

3.2 COORDINATION

A. The structure and its appurtenances, clearances and the related services, such as plumbing, heating, ventilation and electric service, have been planned to be adequate and suitable for the installation of equipment specified under this Section. The Owner will not assume any increase in cost caused by different requirements peculiar to a particular make or type of equipment and any such incidental cost shall be borne by the Fire Protection Contractor. He shall be responsible for the proper installation and location of his required sleeves, chases and inserts and see that they are set in the forms before the concrete is poured. He shall be responsible for his work and equipment furnished and installed by him until the completion and final acceptance of this Contract, and he shall replace any work which may be damaged, lost or stolen, without additional cost to the Owner.

B. In the event there is a conflict or inadequate space for the proper installation of Fire Protection equipment, the Fire Protection Contractor shall prepare a scaled (1/4" = 1'-0" size) composite drawing, showing the building structure and all equipment and items affecting the installation, to clearly identify the areas of conflict. The Fire Protection Contractor shall submit four (4) copies of the drawing, along with a written explanation of the problem, to the Architect for his review and determination on what action to take to resolve the conflict.

C. It shall be the duty of the Fire Protection Contractor to furnish full information to all trades relative to the work they are to do in connection with work under this Section. This includes data for wiring, including wiring diagrams, equipment foundations, pipe connections and related components furnished under other Sections.

3.3 PAINTING

A. The Fire Protection Contractor shall apply one (1) coat of anti-rust paint and one (1) coat of flat black enamel to all support steel, hangers and other steel or iron elements of the Fire Protection system, furnished by him, which will be enclosed or above ceilings when the project is completed.

B. Paint shall be omitted from all items with a galvanized finish.

C. All surfaces to be painted shall be free of dirt, scale, rust, grease and oil. Rust spots are to be wire brushed. Ambient temperature shall be in accordance with paint manufacturer's requirements when painting is being performed.

D. The Fire Protection Contractor shall touch up, with spray paint, all scratched or damaged surfaces of equipment with factory finish. Spray paint shall be the same color and type as factory finish.

E. The Painting Contractor shall paint all mechanical equipment, enclosures, covers, panels, insulation, conduit and other equipment exposed to view, except factory finished items. Care shall be taken not to paint over equipment nameplates. The Fire Protection Contractor shall leave surfaces to be painted ready to receive paint. The Painting Contractor shall apply paint in accordance with the Painting and Finishing portion of this Specification. Colors shall be selected by the Architect.

3.4 WORKING PLANS, FLOW TEST AND HYDRAULIC CALCULATIONS

A. General performance criteria for the fire protection systems has been developed on these Contract Documents. The Contractor is responsible to engage a qualified Massachusetts registered fire protection engineer to prepare the final installation drawings of the fire protection systems. The contractor’s design of the fire protection systems and supporting calculations shall be submitted to the Architect for review, but solely for the purpose of reviewing relative to the criteria established herein. The review of the Contractor's engineer's design shall not, in any manner or respect, relieve the Contractor of full responsibility for any deviations made from the contract drawings of the fire protection systems. It requires preparation and submission of drawings, procurements of approvals and provision of a complete functional system of automatic sprinklers and standpipes.

B. Before commencement of any work, submit and obtain all approvals of all plans and calculations from F.M. or other Insuring Agent prior to submittal to the Agency having jurisdiction, including the Fire Department, for final approval. Furnish copies of approved working plans to the Architect promptly after obtaining such approvals.

C. Plans must show the following information in suitable fashion:
1. Name of Owner.
2. Names and addresses of Architect and Engineers.
3. Location of project.
4. North point.

5. Drawing scale.
6. Plans of all floors, partitions, exits, beams, lights, unit heater, diffusers, registers, duct over four feet (4') in width and ceiling heights.
7. Location, name, type, temperature rating and make of sprinkler heads including dimensioning of heads.
8. Structural beams and penetrations.
9. Source of water supply, size of pipe, and pressure available.
10. Number of sprinklers on each riser, area of each room and total number of rooms in the building, including location and size of risers, mains, branches, and most remote area.
11. Cutting and lengths of pipe.
12. Make, type, model, size and location of sprinkler water flow alarms and tamper switches.
13. Type of hangers, inserts and sleeves.
14. Inspector's test connections, drain pipes and test pipes.
15. Crosses, riser nipples and size.
16. Control gate, checks and flushing connections.
17. Riser diagram of entire schematic system indicating all alarms, valves, tamper switches, floor control valves, mains, risers, source of supply, quantity of sprinklers in each fire area on each floor, water pressure at each floor and height of each floor with regard to water supply source.
18. Symbol list and abbreviations for entire Fire Protection System.

D. The following are the minimum criteria for the systems:
1. All classrooms, hallways and offices shall be protected with a light hazard, wet system employing pendant heads designed to deliver a minimum density of 0.10 gpm/sf. over the most hydraulically remote 1,500 sq. ft.
2. The Kitchen, Gym service areas and mechanical rooms shall be protected with an ordinary hazard wet system designed to deliver a minimum density of 0.15 gpm/sf. over the most hydraulically remote 1,500 sq. ft.
3. The stage area shall be protected with an ordinary hazard 2, wet system designed to deliver a minimum density of 0.20 GPM/SF over the most hydraulically remote 1,500 sq. ft.
4. The areas used for storage of gym equipment, and shall be protected with extra hazard, Group I wet system.
5. The standpipe system shall be designed in accordance with NFPA #14 and the exception noted in Paragraph 905.2.1 of the Massachusetts State Building Code with 150 psi inlet pressure at the Fire Department connection and 100 psi at the most remote hose valve.
6. All systems shall be installed in accordance with NFPA #13, NFPA #14, NFPA #20 and NFPA #24 of the editions indicated by the local fire department.

E. This Contractor shall be responsible to develop complete hydraulic calculations for the Fire Protection System as shown on the Drawings. This Contractor shall perform his own flow tests at building and base his calculations on the flow test results from the exiting fire pump. Elevations of both flow and gauge hydrants must be included with all flow data. Flow test results and hydraulic calculations are to be submitted to the Architect, the Owner's Insuring Agent and the Fire Department for review. A ten (10) psi "cushion" is the minimum required for the design of the piping system.

The building will be served by the existing on-site, 110,000 gallon fire pond with a diesel driven fire pump. The fire pump is a vertical turbine pump extending into a concrete sluiceway. The fire pump driver is Caterpillar 3208 DIT Industrial diesel

engine. The pump is FM/UL unit capable of 251 H.P. This system maintains 150 psi and the pump is tested several times a month and is serviced by a separate outside firm. The exact GPM output of the pump could not be determined from the name plate and a field flow test must be schedule to determine the exact flow and pressure.

END OF SECTION

SECTION 22 00 00
PLUMBING
(Filed Sub-Bid Required)

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SECTION 22 00 00
PLUMBING
(Filed Sub-bid Required)

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. The BIDDING REQUIREMENTS, CONTRACT FORMS, and CONTRACT CONDITIONS as listed in the Table of Contents, and applicable parts of Division 1 - GENERAL REQUIREMENTS shall be included in, and made a part of this Section.

B. Work of this Section requires Filed Sub-Bids and is governed by the provisions of the Massachusetts General Laws (MGL), Public Bidding Law - Chapter 149, Sections 44A to 44J inclusive, as amended, and applicable Sections of the MGL, Public Contract Law - Chapter 30.

C. The work to be completed by the Filed Subcontractor for the work of this Section is shown on the following listed Drawings:

Civil Work Drawings: C0.1 through C6.7 included.

Site Work Drawings: L1.0 through L3.10 inclusive.
Architectural Drawings: A1.01 through A12.19 inclusive.
Food Service Drawings: K1.0 through KK3.2 inclusive
Structural Drawings: S0.01 through S7.01 inclusive.
Plumbing Drawings: P1.11 through P2.7 inclusive.
Fire Protection Drawings: FP1.11 through FP1.34 inclusive.
HVAC Drawings: M0.1 through M4.1 inclusive
Electrical Drawings: ES.1 through E2.16 inclusive.
Telecommunications Drawings: T1.11 through T2.11 inclusive

1. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section. The listing of Contract Drawings above does not limit Filed Subcontractor's responsibility to determine full extent of work of this Section by all Drawings listed in the Drawing List on the Drawing Title Sheet, as modified by Addenda.
2. Refer to Section 01 23 00 - ALTERNATES, for alternates that may affect the scope of Work of this Section.

D. Sub-Bids for work under this Section shall be for the complete work and shall be filed in a sealed envelope with the Awarding Authority at a time and place as stipulated in INVITATION TO BID and INSTRUCTIONS TO BIDDERS.

1. The following shall appear on the upper left hand corner of the envelope:

NAME OF SUB-BIDDER: _____
SUB-BID FOR TRADE: TITLE.

2. Each Sub-Bid submittal for work under this Section shall be on forms furnished by Awarding Authority, as bound herein, accompanied with the required bid deposit in compliance with MGL c149, Section 44B in the amount of 5 percent of Filed Sub-Bid.

E. Sub Sub-Bid Requirements: In accordance with Massachusetts General Law, Chapter 149, Section 44F, as amended, The Filed Sub-Bidder shall list in “Form for Sub-Bids” the name and bid price of each person, firm or corporation performing each class of work or part thereof for which the Section of the Specifications for that Sub-Trade require such listing.

1. This filed trade requires that the following classes of work be listed in under the conditions indicated herein.
   a. Insulation 2.8

1.2 GENERAL REFERENCES

A. Bidding Requirements, Contract Forms, General Conditions Contract for Construction Services and Division 1, General Requirements are hereby made a part of this Section.

1.3 SCOPE OF WORK

A. Work Included: The scope of work of this Section consists of the installation of all materials to be furnished under this SECTION, and without limiting the generality thereof, consists of providing all labor, materials, equipment, plant, transportation, appurtenances, and services necessary and/or incidental to properly complete all plumbing work as shown on the Drawings, as described in the Specifications, or as reasonably inferred from either or, in the opinion of the Architect, as being required and, in general, is as follows:

1. Complete sanitary, waste and vent systems, including kitchen waste, industrial waste and garage waste connecting to all fixtures, equipment and related items, terminating at 10'-0" off the building, as shown on the Drawings or by code for a “Designated System”.
2. Complete storm drainage systems connecting to all roof drains, downspouts and related items, terminating at locations 10'-0" off the building, as shown on the Drawings or by code for a “Designated System”.
3. Complete domestic cold water, hot water and hot water return piping system, including connection to all fixtures, equipment and related items.
4. Acid waste and vent systems from all sinks and fixtures requiring same and terminating, as shown on the drawings.
5. Non-potable water systems from backflow preventors on the domestic water system to all HVAC equipment, recycled water system and science area fixtures and equipment.
6. A tempered emergency water system to supply all emergency showers and eyewashes.
7. All valves for water and gas piping systems.
8. Roof Drains, Floor drains and area drains.
9. Recycled water system with tank, pumps, controls, piping and all related components.
10. A complete vacuum system with piping and receiver to service all Science Rooms indicated on the drawings.
11. Complete compressed air piping systems with all related components to serve certain Science Rooms and the Vocational Shops Area.
12. Cleanouts, thermometers, strainers.
13. Wall hydrants, hose bibbs.
14. Circulator pumps.
15. All plumbing fixtures, trim and fixture supports.
16. Gas-fired water heaters and electric hot water heaters.

17. Exterior Grease Interceptor.
18. Exterior Gasoline Interceptor.
19. Exterior tight tank with alarm system.
20. Insulation of all potable and non-potable hot, cold, hot water return piping, chilled water piping, storm piping and roof drain bodies.
21. Provide sanitary, gas, waste and vent piping, hot and cold water piping including final connections to all equipment supplied under other sections of this Specification complete with all incidental devices.
22. Valve tags, valve charts, nameplates, pipe identification and record drawings.
23. Secure all permits and pay all fees relating to the work.
24. Complete gas piping systems from gas meters, including final connections to all equipment.
25. All operating and maintenance manuals, certification letters and Certificates of Approval. Testing, sterilization and guarantees.
26. All hangers, seismic restraints, inserts, sleeves, expansion loops, expansion compensators, anchors, guides, strainers, gauges, thermometers plus all related accessories required for a complete installation of each system, as specified herein and/or indicated on the drawings.
27. All supplementary steel for piping and equipment supports.

B. Items to be Furnished Only: Furnish the following items for installation by the designated Sections:
   1. Access Panels
      a. Access panels for access to plumbing equipment shall be furnished under this Section for installation by the General Contractor or appropriate Subcontractor.

C. The Plumbing Subcontractor shall be responsible for all cutting related to the work of the Section except in finished surfaces. Patching is the responsibility of the trade affected.
   1. For coordination of cutting and patching, refer to Section 013100 PROJECT MANAGEMENT AND COORDINATION.
   2. For cutting and patching specifications, refer to Section 017300, EXECUTION.

D. The work of this Section is shown on Drawings numbered P1.11, P1.12, P1.13, P1.14, P1.15, P1.16, P1.21, P1.22, P1.23, P1.24, P1.25, P1.26, P1.31, P1.32, P1.33, P1.34, P2.1, P2.2, P2.3, P2.4, P2.5, P2.6 and P2.7.

1.4 RELATED WORK SPECIFIED ELSEWHERE

A. The following related work shall be performed by the Designated trades and under the listed SECTION:
   1. Excavation and backfill shall be performed by the General Contractor: SECTION 310000, EARTHWORK.
   2. On-site storm drainage systems, as shown on the Drawings: STORM DRAINAGE SYSTEMS, SECTION 334000.
   3. Continuation of sanitary drainage systems beyond 10'-0" off the building, as shown on the drawings: SANITARY SEWERAGE, 333000.
   4. Water services up to a point 6" beyond the foundation wall, as shown on the drawings WATER DISTRIBUTION, 331000.
   5. Wiring of equipment requiring power connections and furnished by the Plumbing Subcontractor and starting devices for all motors incidental to the Plumbing Systems shall be furnished and installed by the Electrical Subcontractor: ELECTRICAL, SECTION 26 00 00.

6. Painting of piping, fittings, coverings, hangers, supports and all equipment not specifically outlined to be painted in this Section, shall be painted by the Painting Contractor: PAINTING, SECTION 099100.
7. Electricity and water for all tests and temporary operation of Plumbing Systems: TEMPORARY FACILITIES AND CONTROLS, SECTION 015000.
8. Concrete equipment pads for Plumbing equipment: CAST IN PLACE CONCRETE, SECTION 033000.
9. Equipment access panels for Plumbing equipment shall be furnished by the Plumbing Subcontractor and installed by the General Contractor or respective Subcontractor.
10. Flashing of all vents through the roof shall be performed by the Roofing Contractor, ROOFING AND FLASHING, SECTION 070002.

1.5 DEFINITIONS

A. "Concealed" shall be defined as areas where work is located in chases, walls, partitions, shafts, and above ceilings.

B. "Piping" shall mean, in addition to pipe, all fittings, valves, hangers, and other accessories relating to such piping systems.

C. "Provide" shall mean "provided complete in place," that is, "furnished and installed."

D. "Plumbing Subcontractor" shall mean the filed sub-bid contractor under this DIVISION 22 00 00.

1.6 INTENT

A. All work shall be in accordance with the arrangement, details and locations, as indicated on the Contract Drawings, Reference Drawings and any supplemental addenda, bulletins or drawings issued by the Architect. Layouts are diagrammatic and final arrangement of equipment shall suit field conditions. Install all necessary fittings and equipment offsets required to meet job conditions. The Drawings are not intended to be scaled, but shall be followed with sufficient accuracy to coordinate with other work and structural limitations. Work installed in a manner contrary to that shown on the Drawings, or interfering with the work of another trade, shall be removed and reinstalled when so directed by the Architect. Discrepancies and questionable points shall be immediately reported to the Architect for clarification.

1.7 CODES, REGULATIONS AND STANDARDS

A. All work shall be installed in conformance to the governing Codes, Regulations and Ordinances. It shall be the responsibility of this Contractor to familiarize himself with all governing Codes, Regulations and ordinances and report any non-compliance of the Plans and Specifications to the Architect, prior to entering into a contract. All the above requirements shall take precedence over the Plans and Specifications. These requirements are minimum criteria and no reductions permitted by Code will be allowed without written permission of the Architect.

B. All workmanship, methods and materials shall meet the highest standards of the trade and, in general, shall conform to the standards of the following associations:

American National Standards Institute	(ANSI)
American Society of Mechanical Engineers	(ASME)
National Board of Fire Underwriters	(NBFU)

National Fire Protection Association	(NFPA)
National Electrical Manufacturers Association	(NEMA)
Occupational Safety and Health Act	(OSHA)
Underwriters' Laboratories	(UL)
American Society of Testing Materials	(ASTM)
National Sanitation Foundation	(NSF)
Massachusetts Plumbing and Gas Code	
Massachusetts State Building Code, NFPA 1	
Regulations and Ordinances of the Town of Plymouth	
Americans with Disabilities Act	(ADA)
American Water Works Association Standards	
Mass DEP Regulations	
Town of Plymouth Associated Standards	

1.8 DRAWINGS AND CONFLICTS IN THE WORK

A. The Drawings and Specifications are intended to be complementary. Any materials shown or specified in one, but not in the other, reasonably implied and usually included under good industry practice and/or required by applicable Codes and Regulations for the proper and safe completion and operation of the work described herein, shall be furnished and installed by this Contractor at no additional cost to the Owner. Drawings show general arrangement of equipment and are not intended to indicate the exact dimensions of runs.

1.9 EXCHANGE OF INFORMATION AND COORDINATION

A. All systems and equipment covered by this Section of the Specifications shall not be installed in congested and problem areas without first coordinating the installation of same with the other trades and the General Contractor. This Contractor shall, at his own expense, relocate all equipment installed in congested or problem areas should they interfere with the proper installation of the equipment to be installed by other trades and by the General Contractor.

B. Particular attention shall be directed to the coordination of Systems with all equipment of other trades installed in the ceiling areas. Coordinate, with the other trades, the elevations of all equipment in hung ceiling areas to insure adequate space for the installation of fixtures before said equipment is installed.

C. Furnish to the General Contractor and all other Contractors all information relative to the portion of the installation specified in this Section that will affect them, sufficiently in advance, so that they may plan their work and installations accordingly.

D. In the case of failure on the part of this Contractor to give proper information, as indicated above, sufficiently in advance, this Contractor will pay for all back charges incurred by the General Contractor and other Contractors for the modification and/or relocation of any portion of the work already performed by them in conjunction with this Contract due to this Contractor's delay or for having given incorrect information.

E. Obtain from the other trades, all information relative to the work covered by this Section of the Specifications, which this Contractor is to execute in conjunction with the installation of their respective equipment.

F. In the event that conflicts, if any, cannot be settled rapidly and amicably between the affected trades with work proceeding in a workmanlike manner, then the Architect shall decide which work is to be relocated and his judgement shall be final and binding.

1.10 WORKMANSHIP

A. The entire work provided in this Specification shall be constructed and finished, in every respect, in a workmanlike and substantial manner. It is not intended that the Drawings show every detail, but this Contractor shall furnish and install all such parts as may be necessary to complete the work in accordance with the best trade practice and to the satisfaction of the Architect and the Owner. The Owner shall have the right to reject any part of the work in case the workmanship is not of satisfactory quality and this Contractor shall replace same with acceptable work at his own expense.

1.11 EXAMINATION OF SITE AND DOCUMENTS

A. Bidders are expected to examine and to be thoroughly familiar with all contract documents and with the conditions under which work will be carried out. The Awarding Authority (Owner) will not be responsible for errors, omissions and/or charges for extra work arising from General Contractor or Filed Subcontractor's failure to familiarize themselves with the Contract Documents or existing conditions. By submitting a bid, the Bidder agrees and warrants that he has had the opportunity to examine the site and the Contract Documents, that he is familiar with the conditions and requirements of both and where they require, in any part of the work a given result to be produced, that the Contract Documents are adequate and that he will produce the required results.

B. Pre-Bid Conference: Bidders are strongly encouraged to attend the Pre-Bid conference; refer to INVITATION TO BID for time and date.

1.12 TAXES AND INSURANCE

A. This Contractor shall include in his bid, applicable federal, state and local taxes and the premiums of the insurance required by the General Conditions of the Contract. This Project is exempt from Massachusetts State Sales Tax. Tax exemption number will be given to the successful bidder.

1.13 PERMITS AND INSPECTIONS

A. This Contractor shall obtain and pay for all the permits required for this Section of the work. He shall also obtain and pay for all the inspections and tests required. Defects discovered in work, materials and/or equipment shall be replaced at no cost to the Owner, and the inspection and test shall be repeated. When work is completed, this Contractor shall furnish a Certificate of Inspection and Approval, to the Owner, before final payment of the Contract will be allowed. Permits to be secured through the Town of Plymouth.

B. Refer to Instruction to Bidders and General Conditions Contract for Construction Services.

1.14 CONTRACT COST BREAKDOWN

A. At the start of construction, submit a breakdown of material and labor costs to aid the Architect in determining the value of the work installed, as the job progresses. The cost breakdown shall itemize categories of materials or portions of systems, as may be the case, to place a value on the work as it is installed.

B. No requisitions will be paid until after the breakdown is delivered to the Architect.

1.15 GUARANTEE

A. Unless otherwise noted, all materials, items of equipment and workmanship furnished under this Section shall carry the standard warranty against all defects in material and workmanship for a period of not less than two (2) year from the date of final acceptance of the work. Any fault due to defective or improper material or workmanship which may develop within that period, shall be made good, forthwith, by and at the expense of this Contractor, including all other damage done to areas, materials and other systems resulting from this failure.

B. This Contractor shall guarantee that all elements of the Systems are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated.

C. Upon receipt of notice from the Owner of failure of any part of the Systems during the guarantee period, the affected part or parts shall be promptly replaced by this Contractor, at no charge to the Owner.

D. This Contractor shall furnish, before the final payment is made, a written guarantee covering the above requirements.

1.16 MATERIALS

A. Materials shall be the best of their respective kinds and in full accord with the most modern mechanical construction. All materials shall be new.

B. All materials necessary to make the installation complete in every detail shall be furnished and installed under this Contract, whether or not specifically shown on the Drawings or specified herein.

C. It is the intent of the Specifications that one manufacturer be selected, not a combination, for any particular classification of materials.

D. Where materials, equipment, apparatus or other products are specified by manufacturer, brand name, type or catalog number, such designation is to establish the standard of desired quality and style and shall be the basis of the bid. Unless noted otherwise these manufacturers are not proprietary and it is understood that variations in configuration and appearance do not eliminate other manufacturers as equals.

1.17 MATERIALS AND EQUIPMENT HANDLING

A. This Contractor shall do all handling of his materials and equipment and the resulting cleanup, at his expense, in a safe and satisfactory manner. Special attention shall be paid to the protection of life and property and the equipment or apparatus handled, and any corresponding damages shall be replaced, repaired or paid for by this Contractor. This Contractor shall provide all rigging, hoisting and staging required to complete the work of this Section, unless specifically noted otherwise.

1.18 MAINTENANCE AND PROTECTION OF MATERIALS

A. This Contractor shall be responsible for the maintenance and protection, from loss or damage of all causes, of all equipment, materials and tools supplied by him and stored or installed on the job site, until final acceptance of the project by the Owner.

B. This Contractor shall store his materials and equipment in the location designated by the Owner and maintain the storage area in a safe condition.

C. This Contractor shall clean, patch and repair any material and finishes of the building or its contents damaged during the execution of this Contract.

1.19 SHOP DRAWINGS AND MATERIAL SCHEDULE

A. Submit complete Shop Drawings in accordance with provisions of the General Conditions and Supplementary Conditions of the Contract and Section 013300, SUBMITTAL PROCEDURES.

B. Within 30 days after the date of Notice to Proceed and before purchasing any materials or equipment, submit to the Architect for approval, a complete list of the names of manufacturers of all equipment proposed to fulfill the work of this Section. After the list has been processed by the Architect, submit complete Shop Drawings of all equipment and materials. Do not order any material or equipment until approval has been obtained from the Architect.

C. The approval of equipment and materials does not relieve this Contractor from the responsibility of Shop Drawings errors in details, sizes, quantities and dimensions which deviate from the Specifications, Contract Drawings and/or job conditions as they exist.

D. If apparatus or materials are substituted by this Contractor for those specified, and such substitution necessitates changes in any mechanical or electrical equipment, or alteration to connections, piping, supports, or construction, same shall be provided. This Contractor is to assume the cost and entire responsibility thereof. The Architect's permission to make such a substitution shall not relieve this Contractor from full responsibility for the work.

E. Changes to work already performed, made necessary by delays in Shop Drawing approvals, and are the responsibility of this Contractor.

1.20 LOCATION OF FIXTURES AND EQUIPMENT

A. The Architect will establish the exact location of all fixtures, equipment and devices to be located in finished spaces of the building. Such precise locations are, for the most part, indicated on the Architectural plans of the various spaces, and it shall be the responsibility of this Contractor to obtain instructions from the Architect for the location of any items whose location is not specifically given on the Architectural Drawings. Any work installed contrary to the Architectural Drawings, or without the prior approval of the Architect, shall be relocated and any necessary changing or patching of the surrounding work shall be done at the expense of this Contractor.

1.21 RECORD DRAWINGS

A. The Architect will provide two (2) sets of black or blue line on white drawings to the General Contractor for the purpose of maintaining record drawings, one set of which shall be maintained at the site and on which, at all times, shall accurately, clearly and completely show the actual installation of all work of this SECTION. At the completion of the contract, this Contractor shall submit to the General Contractor a complete set of record drawings showing all "As Built" conditions. After checking the aforementioned drawings, the General Contractor shall certify that they are complete and correct and shall submit the record drawings to the Architect. The Architect may have his Consulting Engineers review the drawings to determine if the installations, as shown thereon, are complete and accurate. After receiving verification that the Record Drawings are complete and accurate, this Contractor shall submit new mylar reproducible copies of the final Record Drawings to the Architect. Each drawing shall be marked "RECORD DRAWING" and dated. Availability of record drawings shall be prerequisite to scheduling a final inspection of this contract and said drawings and original contract documents will be used in checking completion of the work. Non-availability of record drawings or inaccuracies therein may be grounds for cancellation and postponement of any scheduled inspection by the Owner and shall be a condition precedent to final payment until such time as the discrepancy has been corrected. This contractor shall refer to Section 017800 for additional contract requirements to be performed for Record Drawings.

B. The record drawings required to be furnished under this Contract are:

Section	Reference Section	Drawings Required
Plumbing	22 00 00	P1.11, P1.12, P1.13, P1.14, P1.15, P1.16, P1.21, P1.22, P1.23, P1.24, P1.25, P1.26, P1.31, P1.32, P1.33, P1.34, P2.1, P2.2, P2.3, P2.4, P2.5, P2.6 and P2.7

1.22 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

A. Provide qualified trained personnel to insure proper operation of the systems and to train the Owner's operating and maintenance personnel in the proper operation and maintenance of the equipment and systems installed. Instruction period shall be two (2) eight-hour days.

1. "Training of the Tenant's and Building Owner's operation and maintenance personnel is required in cooperation with the Tenant's and Building Owner's Representatives. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Tenant's and Building Owner's Representative after submission and approval of formal training plans. Refer to Commissioning Specification, Section 019110, for contractor training requirements.

B At least two (2) months prior to occupancy or final acceptance of the project, turn over to the Architect, three (3) complete manuals containing the following in accordance with CLOSEOUT SUBMITTALS, SECTION 017800:

1. Complete shop drawings of all equipment.
2. Operation description of all Systems.
3. Names, addresses and telephone numbers of all suppliers of the products, materials, equipment and Systems.
4. Guarantees on all products, materials and equipment.
5. Preventive maintenance instructions for all Systems.
6. Spare parts list of all System components.

C. Each manual shall be typewritten and bound under one (1) hard cover and will be reviewed by the Architect. The manuals shall be clearly and permanently identified on the cover with the name of the project.

D. "This contractor shall refer to Section 017800 for additional contract requirements to be performed for Operating Instructions and Maintenance Manuals."

E. Upon completion of the instructions, this Contractor shall obtain a letter of acceptance of the instructions as being complete from the Owner. Submit a copy of said letter to the Architect.

1.23 COORDINATION DRAWINGS

A. This Contractor shall be responsible to develop and furnish all required information on the coordination drawings required under DIVISION 1 of the specifications. Contractor shall coordinate the elevations and locations of all his systems with the work of all other trades.

1.24 CLEANING OF SYSTEMS

A. Before the Systems are accepted, all equipment shall be thoroughly cleaned, so that no dirt, dust or other foreign matter will be deposited and be detrimental to the operation of the Systems.

B. After the installation is complete, equipment with factory finished surfaces shall be cleaned and damaged or scratched spots shall be touched up with the same type and color paint as applied at the factory.

C. All equipment that is to receive finish paint by the Painting Contractor, shall be cleaned by this Contractor and left ready to have surfaces prepared to receive paint.

1.25 RUBBISH REMOVAL

A. At the completion of each day's work, or when ordered by the General Contractor or the Architect, this Contractor shall remove from the property, all the rubbish or waste material belonging to him. Keep the job site free from accumulation of waste material and rubbish; premises must be maintained in a clean condition.

1.26 TEMPORARY STRUCTURES

A. This Contractor shall provide, on the premises and where directed by the Architect, shall maintain in good condition, and shall remove when directed, suitable and substantial watertight sheds in which he shall store all his materials and equipment.

1.27 TEMPORARY SERVICES

A. All water, electricity, fire protection and sanitary facilities required for safe and efficient construction during normal working hours shall be furnished in accordance with the General Requirements.

1.28 TESTS

A. Furnish all labor, materials, instruments, supplies and services and bear all cost for the accomplishment of the tests herein specified. Correct all defects appearing under test, repeat the tests until no defects are disclosed and leave the equipment clean and ready for use.

B. Perform any tests, other than herein specified, which may be required by legal Authorities or by Agencies to whose requirements this work is to conform.

C. Dispose of test water and wastes after tests are complete, in a manner satisfactory to the Architect and in accordance with governing regulations.

1.29 EQUIPMENT ACCESS REQUIREMENTS

A. All work shall be installed so that all parts requiring inspection, operation, maintenance and repair are readily accessible. Minor deviations from the Drawings may be made to accomplish this, but changes of magnitude shall not be made prior to written approval from the Architect.

B. Furnish access panels in walls and ceilings at locations indicated on the Drawings, or to permit access for adjustment, removal and the replacement and servicing of all equipment, and all other items requiring maintenance and adjustments. Access panels shall be installed by the General Contractor.

C. Coordinate the exact location of access panels in all finished spaces with the Architect.

1.30 MOTOR CHARACTERISTICS

A. Unless otherwise indicated, motors for equipment specified under this Section shall be furnished and installed by the Plumbing Subcontractor and shall be as follows:

1. Motors 1/3 HP and smaller shall be wound for 120 volts, single phase, 60 cycle AC service.
2. Motors 1/2 HP and larger shall be wound for 480 volts, three phase, 60 cycle, A.C. service. See equipment schedules and Electrical Specifications. Motor power factor shall be a minimum of 0.85. Motors shall be the high-efficiency type.

B. Unless otherwise specified, all motor starters shall be furnished and installed by the Electrical Subcontractor.

1.31 WIRING DIAGRAMS

A. This Contractor shall furnish wiring diagrams for all equipment furnished under this Section for which wiring is to be installed by the Electrical Subcontractor.

1.32 CROSS CONNECTIONS

A. No plumbing fixtures, devices or piping shall be installed which will provide a cross or interconnection between a water distributing supply and the drainage system.

1.33 CLEANING, FLUSHING AND TESTING

A. All equipment and piping, including all traps and cleanouts, shall be cleaned to the satisfaction of the Architect.

B. Coordinate all start up, operation and testing activities with the Project Manager, General Contractor and the Commissioning Agent per specification Section 019100.
1. “Contractors’ tests shall be scheduled and documented in accordance with the commissioning requirements. Refer to Commissioning Specification, Section 01 91 10, for further details.”
2. “System verification testing is part of the Commissioning Process. Verification testing shall be performed by the contractor and witnessed and documented by the Commissioning Agent. Refer to Commissioning Specification, Section 01 91 00, for system verification tests and commissioning requirements.”

C. The entire water piping system shall be sterilized in accordance with the following:
1. The entire water distribution system including all cold water, hot water, hot water return, non-potable hot and cold lines and chilled water lines shall be thoroughly sterilized with a solution containing not less than 50 parts per million of available chlorine. The chlorinating materials shall be either liquid chlorine, or calcium hypochlorite, or chlorinated lime. The sterilizing solution shall be allowed to remain in the system for a period of eight (8) hours during which time all valves and faucets shall be opened and closed several times. After sterilization, the solution shall be flushed from the system with clean water until the residual chlorine content is not greater than 0.2 parts per million, unless otherwise directed.

D. After construction is complete, at least four (4) weeks prior to occupancy, the domestic water system of the building shall be tested by a state-approved firm for the level of lead. The system shall be tested at a minimum of five (5) locations in the building, as directed by the Board of Health. Testing shall be done after system has been chlorinated and all fixtures have been thoroughly flushed for at least three (3)

days. A written report of the test results shall be provided to the Owner within seven (7) days of the test. All costs associated with this testing and flushing shall be included in this Contractor's base bid price.

1.34 PROCEDURE FOR TESTING

A. This Contractor shall perform all tests in accordance with Paragraph 1.28 of this Section of the Specifications.

B. Partial tests shall be made, by the progress of the work.

C. Test all piping and connections and make watertight before applying insulation and before concealment, as outlined in the following:
   1. Sanitary System, Kitchen Waste, Garage Waste, Industrial Waste, Acid Waste System and Storm System Piping
      a. All sanitary, kitchen waste, garage waste, industrial waste, acid waste and storm piping shall be tested with water and proved tight to the satisfaction of the Architect and/or Plumbing Inspector before piping is covered and fixtures connected.
      b. Before the installation of fixtures and traps, close all openings of system and fill piping with water to roof and allow to stand for at least 30 minutes until a thorough inspection has been made, after which, if the lines prove tight, the water shall be drawn off and trenches backfilled and fixtures connected.
   2. Water Systems (Including Recycled Water)
      a. All water piping shall be tested to a hydrostatic pressure of 150 psig. All piping shall be proved tight at this pressure before trenches are backfilled. Water piping, if in any way concealed by structural work, shall be tested to the aforesaid pressure and proved tight before pipes are concealed. This test pressure shall be held for a period of not less than one (1) hour. The Plumbing Subcontractor shall make all repairs and alterations in the piping systems necessary to meet the test.
   3. Gas Piping System
      a. All gas piping shall be tested in accordance with rules and regulations of the Massachusetts Gas Code and the National Fuel Gas Code (NFPA 54). In no case shall the tests be less than the following: Test gas piping at not less than an 12" column of mercury and piping shall hold tight for a period of two hours.
   4. Compressed Air Piping
      a. All compressed air piping shall be tested to 100 psi for four (4) hours.
   5. Vacuum Piping
      a. All vacuum system piping shall be tested to 45 in. Hg.

1.35 COMMISSIONING REQUIREMENTS

A. An independent Commissioning Agent (CA) will be retained for this project. The commissioning process will be implemented in accordance with the LEED for Schools v2009 and Commissioning Credits EAp1 – Fundamental Commissioning of Building Energy Systems and EAc3 – Enhanced Commissioning.

B. This contractor shall assist and support the CA as necessary in accordance with the requirements of specification section 01 91 10 – COMMISSIONING

REQUIREMENTS/PLAN.

1. "Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Tenant's and Building Owner's operation and maintenance personnel, is required in cooperation with Tenant's and Building Owner's Representatives and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation and issue closure. Refer to Commissioning Requirements/Plan, Section 01 91 10, for detailed commissioning requirements."

1.36 SEQUENCING

A. Phasing: Refer to Section 01 10 00 - SUMMARY, and Drawings for phasing and milestone completion requirements which affect the General Contractor's Work and the Work of this Filed Subcontract.

B. Coordinate work of this Filed Subcontract with that of other trades, affecting or affected by this work, and cooperate with the other trades as is necessary to assure the steady progress of work.

C. Do not order or deliver any materials until all submittals, required in the listed Specification Sections included as part of this Filed Subcontract, have been received and approved by the Architect.

D. Before proceeding with installation work, inspect all project conditions and all work of other trades to assure that all such conditions and work are suitable to satisfactorily receive the work of this Section and notify the Architect in writing of any which are not. Do not proceed further until corrective work has been completed or waived.

PART 2 PRODUCTS

2.1 INSTALLATION REQUIREMENTS

A. This Contractor shall comply with all the rules, Codes, Ordinances, regulations and requirements of all legally constituted Authorities having jurisdiction over the whole or any part of the work herein specified. Regulations supplement this Specification and shall take precedence in any case of conflict.

B. All equipment and materials furnished in connection with the installation shall be new and furnished in accordance with the requirements of the standards outlined in Paragraph 1.7 and they shall be of the best grade and quality of their respective kinds, free from natural, manufacturing or construction flaws, defects or irregularities and finish, fittings and workmanship shall be equal to the highest commercial grade.

C. Castings of all metals, of all kinds, shall be clean, smooth, close grained, of uniform thickness and free from all defects such as sandholes, blisters or cracks.

D. Before the installation will be accepted, the Plumbing Subcontractor shall have every portion of his work in a first-class working condition.

E. Where installing any of the apparatus herein called for, sufficient clearance shall be allowed to permit the removal and replacing of parts that may require future removal for repairs and replacement.

2.2 PIPE AND FITTINGS

A. Soil, Waste, Kitchen Waste, Garage Waste, Industrial Waste, Vent and Storm Piping

1. Piping materials for sanitary and storm systems inside the building, above the floor slab, including soil, waste and vent piping, unless otherwise noted, shall be standard weight coated hubless cast iron equal to "no-hub" system. Pipe, fittings, couplings and gaskets shall be manufactured in strict accordance with the Cast Iron Soil Pipe Institute's Standard No. 301 and approved for use in Massachusetts. The pipe shall be cast in one piece and with gasket positioning lugs. The pipe shall be legibly marked on the barrel with the manufacturer's name and/or trademark.
2. Piping material for sanitary and storm systems below the floor slab or below grade shall be service weight cast iron soil pipe with hub joints, coated with tar and asphaltum.
3. Vent piping 2" and smaller shall be standard weight galvanized steel or wrought iron with screwed fittings. Waste pipe above ground may be Type "M" copper tubing with solder joint sweat drainage fittings.
4. Indirect waste piping shall be Type "K" copper tubing with sweat solder joint drainage fittings.
5. Urinal branch and fixture wastes shall be of extra heavy cast iron soil pipe and fittings with caulked joints or threaded cast iron pipe with cast iron drainage fittings.

B. Acid Waste and Vent Piping

1. Material for use above the floor slab shall be Schedule 40 polypropylene pipe with mechanical joint fittings. Piping below the floor slab and outside the building shall be Schedule 40 polypropylene with electrically fused joints and fittings. All polypropylene pipe shall be flame retardent.

C. Domestic Water, Chilled Water, Non-potable Water (Including Recycled Water) and Emergency Shower Water Piping

1. All water piping inside the building, except as hereinafter specified, shall be Type "L" hard-drawn copper tubing, as manufactured by Bridgeport Brass, American Brass, Revere Copper and Brass Company, or equal, with solder joints, seamless cast bronze or wrought copper fittings. Water piping buried underground shall be Type "K" soft-temper copper tubing with compression-type cast bronze fittings.
2. Piping for connections between valves and equipment shall be chrome-plated seamless red brass pipe, iron pipe size, containing not less than 85 percent copper and threaded brass fittings, with flat bands, as manufactured by Crane Company, Walworth, Grinnell, Milwaukee or equal.

D. Compressed Air, Gas Piping and Gas Train Vent Piping

1. Compressed Air, Gas piping and gas train vent piping shall be Schedule 40 steel or wrought iron complying with ANSI Standard for Wrought Steel or Wrought Iron Pipe, B36.10-1970. A suitable drip or condensation pocket shall be installed at all points in accordance with the requirements of all applicable Codes.

E. Vacuum Piping

1. All vacuum piping shall be of type “L” copper (ASTM B280) tubing and fittings joined by bracing in accordance with NFPA #99, after cleaning and degreasing. All elbows shall be long sweep type.

2.3 JOINTS AND COUPLINGS

A. Soil, Waste, Kitchen Waste, Garage Waste, Industrial Waste, Vent and Storm Piping Joints

1. Couplings on all hubless cast iron piping shall consist of a stainless steel shield, band and tightening device, and a neoprene gasket assembled at the factory as a complete unit. Couplings shall be marked with manufacturer's name and number and shall meet ASTM C564 Specifications.
2. Joints for service weight cast iron pipe shall be made with resilient rubber gaskets.
3. All joints in threaded pipe shall be American National taper screw threads. Apply graphite and oil compound to the male threads only.
4. Joints between steel, wrought iron and cast iron shall be made with Manhoff Fitting screwed into threaded pipe and caulked into the cast iron pipe.
5. Every connection between drainage pipes and water closets, floor outlet service sinks, pedestal urinals, and earthenware trap standards or other fixtures with floor outlet, shall be made with brass, wrought copper, hard lead, iron or plastic flanges that are caulked, soldered or screwed to the drainage pipe. The fixture shall be bolted to the flanged connection, with an approved gasket, washer or setting compound between the fixture and the flange. Only brass or stainless steel nuts and bolts shall be used. The floor flange shall be fastened to a structurally firm base. The use of commercial putty or plaster as a setting compound is prohibited.

B. Acid Waste and Vent Piping Joints

1. Joints in acid waste and vent piping above the floor slab shall be mechanical-joint type with cut grooves, a sealing ring and appropriate fitting.
2. Joints in acid waste and vent piping below the floor slab shall have socket-type fittings, compatible with the piping and have a heavy gauge resistance wire molded into them. All joints shall be electrically fused for a complete seal.

C. Domestic Water, Chilled Water, Non-potable Water (Including Recycled Water) and Emergency Shower Water Piping Joints

1. Copper tubing and sweat fittings shall be assembled with 95-5, lead free, tin and antimony solder composition with a 1000EF melting point and a non-corrosive flux.
2. All copper piping 1-1/2" and larger shall have all tubing and fittings tinned prior to assembly.
3. Joints between copper tubing and iron pipe or at connections to tanks shall be made with a combination iron and brass flange with composition gasket and iron bolts.

D. Compressed Air, Gas Piping Joints and Gas Train Vent Piping Joints

1. Joints in compressed air, gas piping and gas train vent systems shall be made with malleable iron fittings and tape for pipe 3" and smaller. Pipe larger than 3" shall have welded joints, conforming to ANSI B31-2 Code for Pressure Piping, Chapter 5, API Standard 1104 and ASME Boiler and Pressure Vessel Codes, Section 9.

E. Vacuum Piping Joints

1. All joints shall be made by bracing in accordance with NFPA #99, after cleaning and degreasing.

2.4 VALVES

A. General
1. Furnish and install valves, where indicated on the Drawings or specified, so located that they may be operated, repaired or replaced with a minimum effort and repacked under pressure.
2. The basic system of valves (i.e., gate, globe, check for water service) shall be one manufacturer.
3. Valves shall be Apollo, Jenkins, Walworth or equal.

B. Water System Valves
1. Furnish and install valves, where indicated on drawings or specified, so located that they may be operated, repaired or replaced with a minimum effort and repacked under pressure.
2. The following list of valves is intended only as a guide for type and quality to this Contractor:

Ball Valves	3" and smaller	Apollo #70-200
Ball Valves	4" in size	Apollo #78-255
Gate Valves	4" and larger	Jenkins #677-A
Balancing Valve		Apollo #70-200 with memory stop
Check Valves	3" and smaller	Jenkins #4093
Drain-Off Valves		Apollo #78-204

3. All fixture supplies and supplies to equipment not already furnished as such shall have angle or straight compression stops, unless otherwise specified.
4. Drain valves shall be installed to drain the water from all sections of the hot water, hot water return and cold water piping. Furnish and install 1/2" all brass plug cocks with hose connections on each drain.

C. Gas System Valves
1. Gas cocks shall be furnished and installed at connection to each piece of equipment, at each riser and where shown on the Drawings. Gas cocks shall be brass body tee handle types with Boston Key, manufactured in accordance with the local gas company requirements.

D. Compressed Air System Valves
1. Compressed air system valves shall be ball valves, Apollo No. 70-100 or equal.

E. Vacuum System Valves
1. Vacuum system valves shall be bronze ball valves.

2.5 PIPE HANGERS, SUPPORTS, CHANNELS AND SEISMIC RESTRAINTS

A. All piping shall be rigidly supported from the building structure by means of approved hangers and supports. Pipes shall be supported so as to maintain the required grading and pitching of lines, to prevent vibration and to secure piping in place; they shall be arranged so as to provide for proper expansion and contraction of pipe.

B. Spacing of hangers for horizontal piping shall be in accordance with the following:
1. Cast Iron Soil Pipe - 5'-0" at the hubs for 5' lengths, and for 10' lengths use 1 hanger at the hub and 1 at mid-point of the length. On "no-hub" pipe, install additional hangers on each side of each joint.
2. Copper Tubing - 6'-0" o.c. for 1-1/4" and smaller. 10'-0" o.c. for 1-1/2" and larger.

3. Threaded Steel Pipe - 10'-0" o.c.
4. Acid Waste and Vent System Pipe - 4'-0" for pipe 2" and smaller and 5'-0" for pipe 3" and 4" in size.

C. If Codes having jurisdiction require closer spacing, the hanger spacing shall be by Code in lieu of the foregoing. Provide hangers at all changes in direction and on both sides of concentrated loads (valves, strainers and regulators).

D. Hangers shall be adjustable clevis hangers. Hanger rods shall have machine threads. Malleable iron brackets of approved type shall be used along the walls.

E. Hangers shall be Grinnell Company, Carpenter and Patterson or Fee and Mason.

F. Wire and strap hangers will not be permitted in this installation.

G. Friction clamps shall be installed at the base of all plumbing risers and at each floor.

H. Where three or more pipes are running parallel, gang type hangers may be used in lieu of the aforementioned clevis hangers. These hangers shall be sized to provide the insulation protectors as hereinafter specified. Separable saddles shall be used for each pipe on gang hangers. Where saddle slips are installed for uninsulated copper piping, they shall be constructed of 16 gauge (minimum) copper.

I. Field painting or spraying of hangers, rods and nuts in lieu of copper plating will not be acceptable.

J. All vertical lines, drops and run outs, including insulated pipes, shall be supported by split-ring extension type hangers or equal. These hangers shall be copper-plated when used on uncovered copper tubing. Supports on insulated piping shall be sized to fit the outside diameter of the pipe insulation. Hangers shall be placed in the horizontal line near the riser and at ten foot (10') intervals or at each floor slab.

K. All horizontal piping shall be suspended from the building by mild galvanized steel rod connecting the pipe hanger to inserts, beam clamps, angle brackets and lag screws, by the building construction, in accordance with the following:

PIPE SIZE (inches)	ROD DIAMETER (inches)
3/4 - 2	3/8
2-1/2 - 3-1/2	1/2
4 - 6	3/4
8 - 10	1

L. Hanger rods for other installations shall be sized in accordance with recommended load capacities of Specification ASTM A107.

M. All hangers on insulated lines shall be sized to fit the outside diameter of the pipe insulation. Provide pipe covering protection saddles at all hangers on insulated lines of sheet metal, 18 gauge, and twelve inches (12"), minimum length, and shall cover 180 degrees of arc (lower quadrants) on the covering at all hangers on insulated piping systems.

N. Remove rust from all ferrous hanger equipment immediately after erection.

O. Miscellaneous trapeze hangers for pipe supports with inserts and steel for interior plumbing stack and riser supports indicated shall be provided by this Contractor.

P. Piping at all equipment and control valves shall be supported to prevent strains or distortions in the connected equipment and control valves. Piping shall be supported to allow for removal of equipment, valves and accessories with a minimum of dismantling and without requiring additional support after these items are removed.

Q. All factory fabricated channels with related accessories for piping supports shall be Unistrut Corporation or approved equal. Channels and fittings shall be constructed of bonderized steel, coated with a corrosion-resistant primer and ovenbaked. All other related accessories (nuts, bolts, rollers, washers, couplers, springs and related components) shall be electro-galvanized finished.

R. All piping installed under this Section of the Specifications shall be independently supported from the building structure and not from piping, ductwork or conduit of other trades. All supplementary steel, including factory fabricated channels required to meet the requirements specified herein, shall be furnished and installed by this Contractor.

S. All pipe hangers and equipment supports shall be constructed and installed in accordance with Seismic Zone requirements as outlined in the State Building code. This Contractor shall submit one (1) copy of shop drawings and calculations detailing seismic hanger restraints to the local Building Authority and Architect, along with a letter of compliance signed by a registered structural engineer confirming that the piping hangers meet state seismic code requirements. Cable provided for seismic systems shall be color coded and pre-stressed.

2.6 ACCESS PANELS

A. Furnish access panels for installation by the General Contractor, in walls and non-accessible ceilings, at locations to permit access for adjustment, removal and replacement of all equipment, such as valves, traps, vacuum breakers, and all other items requiring maintenance and adjustment.

B. All access panels shall be located in closets, storage rooms and/or other non-public areas, in a workmanlike manner, positioned so that the junction can be easily reached, and the size shall be sufficient for this purpose (minimum 16" x 16"). When access panels are required in corridors or other finished areas, they shall be located as directed by the Architect.

C. Panels shall be of the types specified in Section 083100 and shall be set square and flush in cooperation with the Subcontractors for other Sections of the Specifications. Particular attention shall be exercised in the selection of doors for masonry walls in order that frame sizes used will match the courses of concrete masonry units.

D. Access panels Shop Drawings shall be submitted to the Architect for approval.

2.7 PIPE SLEEVES

A. General

1. All pipe sleeves shall be furnished and set by this Contractor. Their location and setting shall be carefully coordinated with the requirements or limitations of the structural member they are passing through. Any conflict arising shall be solved by utilizing the best trade practices.

B. Sleeves and plates shall be black steel, Schedule 40, in accordance with A.S.T.M. Specifications A-120.

C. They shall be provided at all joints where pipes pass through concrete or masonry. They shall be sized so as to provide for pipe covering and for lateral expansion.

D. The ends shall be flush with the surfaces, except in floors, where it is possible for water to accumulate, such as toilets and janitor's closets, in which cases, they shall terminate one inch (1") above the finish floor.

E. Where pipes pass through partitions, ceilings and furring (plaster and glazed tile), furnish and install No. 24 gauge galvanized iron sleeves, over which furnish and install cast metal floor plates of the escutcheon type, designed to cover the sleeves and to remain in permanent position.

F. This contractor shall be responsible to review all fire stopping of all piping and related components for completeness. All fire stopping materials and installation will be by the general Contractor under Section 078400.

G. Furnish labor to set and fasten all sleeves before the floors and walls are finally constructed.

H. Provide chromium-plated escutcheon plates at all exposed locations in finished rooms where pipes pass through walls, floors and ceilings.

2.8 INSULATION

A. All water piping, all storm piping (horizontal and vertical) and all equipment installed under this Contract shall be covered as follows:

Piping or Apparatus	Insulation
All cold water, hot water, hot water return, storm, chilled water, non-potable cold water, non-potable hot water, recycled water, tempered emergency shower supply and return water piping.	I.P.S. ½" to 6" – 1" thickness, 8" and larger – 1-1/2" thickness – both of fiberglass, heavy density, snap-on type
All valves and fittings on insulated lines and underside of roof drain bodies	Pre-molded PVC covers packed to 1" thickness with fiberglass
All trap primer piping and cold water and hot water piping below slab or in masonry walls	¾" closed-cell neoprene insulation
All supplies and wastes associated with handicapped lavatories	Modeled closed-cell vinyl insulation equal to Handi-Lav-Guard Model #103

B. Apply all insulation over clean, dry surfaces with all joints firmly butted together. Perform all tests prior to covering.

C. All fiberglass insulation shall be furnished with factory-applied, all-purpose, vinyl-coated and embossed vapor barrier laminate with pressure sealing lap adhesive seam. Openings, joints, and end strips shall be sealed against moisture penetration with vapor barrier cement.

D. Insulation shall be as manufactured by Gustin-Bacon Manufacturing Company. Owens-Corning Fiberglass Corporation, or Johns-Manville, and shall be applied by skilled insulation mechanics employed by an insulation contractor.

E. All insulation shall run continuously through walls, floors and ceilings.

2.9 CLEANOUTS

A. Cleanouts shall be installed where indicated on the drawings and/or where required in soil, waste, acid waste and storm pipes. Cleanouts shall be installed at the base of all risers and at each change of direction. In storm system, install cleanouts same as for soil or waste piping or dandy cleanouts before going below grade.

B. Cleanout plugs shall be heavy cast brass of the screwed type, full size up to and including four inches (4").

C. Cleanouts shall be same size as pipe for piping up to four inches (4") in size and not less than four inches (4") for piping larger than four inches (4").

D. For piping running under floor slab, cleanouts shall be brought up to just under the floor slab level.

E. Access cover for concrete floor type cleanouts shall be J.R. Smith 4043 bronze top; tile floor type shall be J.R. Smith 4163; carpeted floor type shall be J.R. Smith 4043-Y.

F. Access to cleanouts in walls shall be provided by an access panel.

G. All cleanout access covers shall be manufactured by J.R. Smith, Zurn or Josam.

2.10 TRAPS

A. Furnish and install traps with cleanouts on all fixtures and equipment requiring connection to the sanitary system of the same size and material as the pipe in which they occur.

B. Traps installed on threaded pipe shall be recessed drainage pattern.

C. Fixture traps shall be self-scouring and shall have no interior partitions except where such traps are integral with the fixture. Slip joints or coupling may be used on the trap inlet or within the trap seal of the trap if a metal-to-metal ground joint is used. Each fixture trap, except a trap that is cast integrally or in combination with the fixture in which the trap seal is readily accessible or except when a portion of the trap is removable for cleaning purposes, shall have an accessible cleanout plug of ample size that is protected by the water seal.

D. Fixture traps shall be made of cast brass with wall thickness of not less than 0.1 inch. All exposed traps shall have a polished chrome finish.

E. Strainers, C.O. plugs, tailpieces, waste arms, and overflows and any other similar fixture to trap connection when of metal, shall be made of brass or other approved non-corrosive metal, not less than 17 gauge thickness.

F. Traps shall be set level with respect to their water seals.

2.11 UNIONS AND NIPPLES

A. Union connections installed on brass pipe two inches (2") in diameter and smaller shall be brass composition "E" in strict accordance with Federal Specification WW-U-516.

B. Piping shall be installed with unions properly spaced to permit alterations and repairs.

C. All connections between copper tubing and galvanized tanks or piping shall be made with dielectric unions.

D. All close and shoulder nipples shall be of corresponding materials as the pipe and shall be extra heavy design.

2.12 SHOCK ABSORBERS

A. Furnish and install, where shown on the Drawings or by Code, shock absorbers properly sized and in accordance with Plumbing and Drainage "Standard P.D.I. WH201." These units shall be equal to the Smith "Hydrotrols" type units. Shock Absorbers by Josam, Zurn or Watts are acceptable.

B. All shock absorbers must be located behind access panels or in readily accessible areas.

C. Installation of shock absorbers shall conform to manufacturer's recommendations.

2.13 VACUUM BREAKERS

A. Approved vacuum breakers shall be installed with any plumbing fixture or equipment in which the potable supply outlet may be submerged and which cannot be protected by the minimum air gap. This includes all fixtures with hoses or a means for attaching hoses.

B. All vacuum breakers shall be certified by a recognized testing laboratory acceptable to the Administrative Authority.

C. Vacuum breakers shall be installed with the critical level at least six inches (6") above the fixture they serve and on the discharge side of any control valve.

2.14 PIPING ACCESSORIES

A. Vacuum reliefs shall be Watts Regulator Company #36 or approved equal.

B. Thermometers shall be 4-1/2 inches in diameter, and angle with a range of 40°F. to 240°F., as manufactured by Albert A. Weiss and Son, Inc. Include thermometer well.

C. Pressure and temperature relief valves shall be ASME Rated, temperature relief 210°F., pressure relief 125 psi, double Btu rated, self-closing, as manufactured by Watts Regulator Company or approved equal.

D. Pressure gauges shall be four inches (4") in diameter with a range of 0 to 150 psi, as manufactured by U.S. Gauge.

2.15 VENTS THROUGH THE ROOF

A. All pipes extending through the roof for the sanitary or waste systems or acid waste system shall be the same material as that piping system. Vents shall be of sizes indicated on the Drawings and extend at least 18 inches above the roof, ending in the top of pipe, which will be flashed by the General Contractor. Any vent pipe within 25'-0" of an outdoor air intake shall extend a minimum of 2'-0" above the air intake.

2.16 DRAINS

A. Drains shall be provided as indicated on the drawings. Furnish and install all floor drains and roof drains. Coordinate installation of all flashing collars of roof drains with the Roofing Contractor. Plumbing Subcontractor shall be responsible for the proper location of the various sizes and types of drains furnished by him.

B. Drains in waterproof floors and areas shall have galvanized iron clamping rings with six (6) pound lead flashing to bond nine inches (9") in all directions. Drains shall be checked with Architect's drawings to determine depth of the flashing collar. Brass extension pieces shall be provided if necessary.

C. Floor drains shall be by J.R.SMITH, Josam, Zurn and shall be equal to the following schedule:

1. Floor Drain "A" (General Areas) - J.R. Smith Figure 2010-A-P-050, cast iron body drain with flashing collar, adjustable, nickel bronze strainer head and trap primer connection. Unit to have four-inch (4") IPS outlet and deep seal trap.
2. Floor Drain “B” (Kitchen Area drain) - J.R. Smith Figure 3020, cast iron receptor with acid-resisting porcelain-enameled interior and nickel bronze rim and grate with flashing flange, lumaloy bottom strainer, four inch (4") IPS trap and outlet.
3. Floor Drain “C” (Kitchen Deep Drain) - J.R. Smith Figure 3061, cast iron receptor with acid-resisting, porcelain-enameled interior with nickel-bronze tops and four inch (4") IPS outlet and deep seal trap. Provide funnel drain with each unit, Figure 3581.
4. Floor Drain "D" (Dishwasher) - J.R. Smith Figure 3061, cast iron receptor with acid-resisting , porcelain-enameled interior with nickel-bronze, 3/4 grate and four-inch (4") IPS outlet with trap primer fitting and deep seal trap.
5. Floor Drain "E" (Science Rooms) - J.R. Smith Figure 3020, cast iron body drain with acid resistant coated interior and flashing collar. Drain to have four inch (4") IPS outlet with trap primer fitting and deep seal trap.
6. Floor Drain "F" (Mechanical Areas) - J.R. Smith Figure 2142 floor drain with cast iron body and cast iron tractor grate. Unit to have four-inch (4") IPS outlet with trap primer fitting and deep seal trap.
7. Floor Drain “G” (Garage Area) – J.R. Smith Figure 2142 floor drain with cast iron tractor grate and sediment bucket. Unit to have four-inch (4") IPS outlet with trap primer fitting and deep seal trap.

D. Roof drains shall be equal to the following schedule:

1. Roof Drain "A" - J.R. Smith Figure 1010-R-C-E-U-AD with Duco cast iron body, clamping collar, extension and aluminum dome, having 1/8” mesh stainless steel on dome. Outlet size as shown on the drawings.

E. Kitchen Trench Drains are to be furnished by the Kitchen Equipment Contractor and installed and piped by the Plumbing Subcontractor.

F. Automotive Shop Trench Drains shall be equal to J.R. Smith Modular Trench Drains

Figure 2710 C-DH-F-DBS-M with ductile iron grates. Length of each unit to be as shown on the drawings.

G. All floor drains and trench drains not provided with type primers shall be installed with an in-line trap sealer insert as manufactured by Sure Seal, Inc or equal.

2.17 WALL HYDRANTS, ROOF HYDRANTS AND HOSE BIBBS

A. Furnish and install, where indicated on the Drawings and mounted at elevations indicated on the Drawings, wall hydrants equal to the following unit: J.R. Smith Figure 5609-NB, or equal, bronze hydrant with nickel/bronze face and hose connection having an integral vacuum breaker. Unit to have removable brass "T" handle.

B. Furnish and install, where indicated on the drawings, a roof hydrant. Roof hydrant to be Woodford Model SRH-MS or equal

C. Furnish and install, where indicated on the Drawings and mounted 18" above the finished floor, hose bibbs equal to the following unit: Hose Bibb "A" shall be a single temperature, solid bronze wall faucet with threaded spout and pail hook notch, Chicago Model No. 952 or equal.

D. Furnish and install, where indicated on the Drawings and mounted 18" above the finished floor, hose bibbs equal to the following unit: Hose Bibb "B" shall be a single temperature, solid bronze wall faucet with threaded spout and pail hook notch, Chicago Model No. 998-RCF or equal.

2.18 EQUIPMENT CONNECTIONS

A. Certain equipment will be furnished and installed by General Contractor. They will be provided with strainers, tailpieces, waste valves and faucets. The Plumbing Subcontractor shall furnish and install traps, drains, stop valves, water piping and waste piping, as specified herein, to all kitchen and science equipment.

B. All water, waste and vent piping which is located under counters or exposed at plumbing fixtures or food service equipment shall be chrome-plated or have chrome-plated cover tubes.

2.19 GAS SOLENOID VALVES

A. This Contractor shall furnish and install gas solenoid valves (Solenoid Valve #1) to automatically shut off the supply of gas to the cooking equipment. Each gas valve shall be of the type compatible with the hood's fire suppression system and shall be installed complete with all required cable, enclosure, pulleys and related components, necessary to connect valve to suppression system. Systems shall be tested several times, in the presence of the Owner, upon completion to insure proper operation.

B. “Downstream of each of the above outlined gas solenoid valves, this contractor shall install an ASCO, or equal Model 8214 gas solenoid valve (Valve #2) which shall be interlocked with each hood’s exhaust fan and co-detection system.”

C. The above outlined pairs of valves shall be provided at each fire suppression hood system and cooking equipment, refer to drawings for all locations.

2.20 SCIENCE ROOM GAS VALVE BOXES

A. Master Gas Valve Boxes
1. Master Gas Valve boxes shall be furnished and installed by this contractor as detailed on Drawing P2.4.

2.21 GAS SERVICES AND METERS

A. Gas service up to each building, including meter, will be performed by the local Utility Company.

B. Cost of work will be back charged to the Owner. The Plumbing Subcontractor must contact the Gas Company and coordinate the proper timing of the services and meter installations.

C. This Contractor shall coordinate with the Gas Company to insure proper installation of meter with regards to location.

2.22 INTERIOR GREASE INTERCEPTORS

A. This Contractor shall furnish and install five (5) interior grease interceptors; two (2) in the School's Kitchen area, two (2) in the School's Culinary Kitchen, and one (1) in the Concession Building, which are complete in all respects. Interceptors shall be as manufactured by J.R. Smith, Zurn, Josam or equal.

B. Grease interceptors "A", "B" "C", "D" and "E" shall be equal to J.R. Smith Figure 8350 grease interceptor with cradle, having acid-resistant epoxy inside and outside, and flow control fitting having a rating of 50 GPM and grease capacity of 100 pounds, bearing approval seal of the Plumbing and Drainage Institute. Interceptors to have three inch (3") non-submerged inlet and three inch (3") outlet connections, internal air-relief double wall deep seal code trap and removable baffles.

2.23 BACKFLOW PREVENTERS

A. Furnish and install a reduced pressure type backflow preventer (RPB-1) in the Mechanical Room in the make-up water supply to the HVAC system. Backflow preventer shall be of the size indicated on the Drawings. Device shall be equal to Watts Model No. 909.

B. Furnish and install two (2) reduced-pressure type backflow preventers in the make-up water supply to the recycled water system. Devices RPB-2A and RPB-2B shall be installed in parallel. Backflow preventer shall be of the size indicated on the drawings. Devices shall be equal to a Watts Model 909.

C. Furnish and install reduced-pressure type backflow preventers in the non-potable water feeds to the science areas. Device RPB-3 (2-1/2" in size) shall be installed in the cold water supply. RPB-4 (2-1/2" in size) shall be installed in the hot water supply. Devices shall be equal to a Watts Model 909.

D. Furnish and install a reduced pressure type backflow preventer (RPB-5) in the Kitchen, in the water supply to the ware washer. Backflow preventer shall be of the size indicated on the Drawings. Device shall be equal to Watts Model No. 909.

E. Furnish and install a double check backflow preventer (DCBP-1) on the outlet side of the tempering valve for the emergency shower water supply. Backflow preventer shall be of the size indicated on the drawings. Device shall be equal to a Watts Model 007.

F. Backflow preventers shall be by Watts, Apollo or Willkins.

G. Spare parts kits shall be provided with all backflow preventers and shall be attached to each unit.

H. This Contractor shall be responsible to file design data sheets, along with cuts of all backflow preventers, and obtain approval of same from the local Water Department and the Department of Environmental Protection.

2.24 TRAP PRIMERS

A. Furnish and install, where shown on the Drawings, automatic trap primers, of the pressure-drop type, complete with all associated piping, to all floor drains indicated on the Drawings. Trap primers shall be equal to Precision Plumbing Products - Oregon No. 1. Type “A” to have one-pipe distribution unit; Type “B” to have two-pipe distribution unit. Type “C” to have three-pipe distribution unit. Type “D” to have four-pipe distribution unit. Trap primers shall be installed in accessible locations or with access panels to permit servicing.

2.25 EXPANSION JOINTS AND LOOPS

A. Expansion joints for piping systems shall be located to prevent undue strain in the piping system, equipment or building structure.

B. Piping shall be so installed as to permit expansion and contraction degrees of anticipated installation area temperature.

C. Domestic Water Piping Systems
   1. Provide expansion loops in all piping mains, where shown on the Drawings, of dimensions as indicated on the Drawings.

2.26 GAS FIRED HOT WATER HEATING SYSTEMS (MAIN SCHOOL BUILDING)

A. This contractor shall furnish and install, complete in every respect, two (3) hot water heaters, with balanced manifold piping, as detailed on the drawings. Each heater shall be equal to an AO Smith Commercial Gas Water Heater (Cyclone) Model BTH-500 (A).
Input – 499,900 BTU/HR.
Recovery – 523 GPH per 100°F rise
Storage – 199 Gallons

B. Each hot water heater shall be of glass-lined design and include a powered gas burner with electronic flame safeguard, intermittent ignition, main and pilot automatic gas valves, redundant solenoid gas valve, gas pressure regulator, diaphragm air switch for proof of blower operation, and flame inspection port. Maximum supply gas pressure to heater 14” W.C. Minimum pressure to be 4.8” W.C. Heater shall be equipped with 1-1/2” NPT water inlet and outlet openings, (2) 3” handhole cleanouts, shall have an ASME working pressure of 160 psi, and stamped National Board, and listed by Underwriters Laboratories. Controls shall include : high temperature limit control (Manual reset), upper and lower thermostats, combination termpreature and pressure gauge, low water cutoff, ASME rated temperature relief valve, drain valve and draft regulator. Control compartment door shall be hinged for easy access. The heaters shall be equipped with multiple anodes for cathodic protection. The heaters shall be insulated with vermin-proof glass fiber insulation or equal. Heaters must meet or exceed current ASHRAE/IES 90.1b-1192 for recovery efficiency and standby loss. The outer jacket

shall have baked enamel finish. All internal surfaces of the heaters exposed to water shall be glass-lined with alkaline borosilicate, nickelous oxide composition that has been fused to stgeeel by firing at a temperature range of 1400°F to 1600°F. Heaters tank shall have a 10 year limited warranty against corrosion as outlined in the written warranty. Manufacturer's professional start-up service to be included.

2.27 EMERGENCY SHOWER ELECTRIC HOT WATER SYSTEM (MAIN SCHOOL BUILDING)

A. This Contractor shall furnish and install an electric hot water heater on a shelf, in the Acid Neutralization Room.

B. Electric hot water heater shall be as manufactured by Hubbell, or equal, with a 1.5 K.W. element, combined adjustable thermostatic control for 30° to 110°, set at 85°F and on/off switch. Heater to be equal to Model No. E06. Unit to have a 6 gallon cement-lined tank surrounded by foam insulation with a one (1) year warranty. Heater shall be installed complete with relief valve and all related components by the Massachusetts State plumbing Code.

2.28 GAS HOT WATER HEATING SYSTEM – (SUPPORT/STORAGE/RESTROOM FACILITY BUILDING) – (ALTERNATE #2)

A. This contractor shall furnish and install, complete in every respect, one (1) hot water heater, as detailed on the drawings. Heater shall be equal to an Eternal model GU145S.

B. Thermal efficiency 97%, sealed combustion, 3 inch PVC vent, condensate discharge 0.5 GPH, condensate pH level 4 pH, natural gas supply,

2.29 ELECTRIC HOT WATER HEATING SYSTEM – (WASTE WATER TREATMENT BUILDING) – (ALTERNATE #1)

A. This contractor shall furnish and install, complete in every respect, one (1) hot water heater, as detailed on the drawings. Heater shall be equal to a Hubbell model EMV.

B. Tank shall be Hydrastone cement lined steel, storage capacity 120 gallons, vertical, 480 volt, single phase, tank warranty of 5 years, electrical warranty of 1 year,

2.30 DOMESTIC WATER TEMPERING SYSTEM

A. This Contractor shall furnish and install, as detailed on the Drawings, one (1) domestic water tempering systems, equal to a Leonard Type TM-186-20015020PRV-RF-0-LTR with two (2) thermostatic mixing valves in a parallel installation, with integral check stops and wall support. Capacity shall be 182 GPM at 8 psig pressure drop with a range of 85° to 140°F. Units by Leonard, Powers, Lawler or equal are acceptable.

B. Units to be installed and piped in accordance with all manufacturer's recommendations.

C. This Contractor shall furnish, with each unit, one (1) complete repair kit to allow that mixing assembly to be totally rebuilt.

D. Provide a Symmons temp-control model 5-400A-W-V in the (Support/Storage/Restroom Facility Building) – (Alternate # 2)

2.31 EMERGENCY SHOWER WATER TEMPERING VALVE

A. This Contractor shall furnish and install, as detailed on the Drawings, one (1) emergency shower water tempering valve equal to a Leonard Model No. TM-5125, or equal, capable of delivering 99 GPM at a 30 psig pressure drop. Units by Leonard, Lawler or Powers, or equal are acceptable.

B. This Contractor shall furnish, with the unit, one (1) complete repair kit to allow the mixing assembly to be totally rebuilt.

2.32 HOT WATER CIRCULATORS

A. This Contractor shall install building circulator pumps where shown on the drawings. Pumps shall be Bell + Gossett, Taco or Armstrong. These units shall be rigidly mounted on iron pipe brackets. All wiring connections shall be done by the Electrical Subcontractor. Circulators shall be all bronze, capacity of all 120°F circulators shall be 10 GPM at 16 ft. head and shall be equal to a Bell & Gossett Model PR with a 1/6 HP, 120 volt, 1 phase motor. Capacity of the emergency shower circulator shall be 9 GPM at 10 ft. head and shall be equal to a Bell & Gossett Model PR with a 1/6 HP, 120 volt, 1 phase motor. Capacity of the 140°F circulator shall be 7 GPM at 10 ft. head and shall be equal to a Bell & Gossett Model HV with a 1/6 HP, 120 volt, 1 phase motor. Units shall have an adjustable aquastats to regulate operation of motor. Units shall be set to operate to provide a water temperature of 5°F below supply temperature.

B. This Contractor shall be responsible to balance each primary 120ºF return system to a flow of 10 GPM and each secondary 120°F hot water return leg to a flow of 5 GPM and the 140ºF hot water return line to 10 GPM and each leg of the emergency shower system to 4 GPM. A final report indicating flows shall be provided. Flow control valves shall be used as balancing valves.

2.33 PH NEUTRALIZATION SYSTEM

A. System Description
1. The Neutralization System shall be a completely integrated, engineered, pre-packaged unit including automatic controls and instrumentation. The monolithic, integral design shall consist of a polypropylene shell including a reaction chamber, agitator, two reagent tank chambers with secondary containment, two metering pump compartments and control panel. The system shall be Model PHX-(500)EM as manufactured by Burt Process Equipment, Hamden, (203-287-1985).

B. Reaction Tank Chamber
1. The reaction chamber shall be thermally formed and butt fusion welded in ½" thick Blue polypropylene. Adequate structural girthing shall be provided internally to prevent wall deflection. The tank shall have a flat bottom a nominal capacity of (500) gallons. The tank shall be fitted with proper inlet outlet and vent connections triple welded and reinforced. The top shall include an opening sized for angled entry of the agitator shaft as well as epoxy coated mixer support rails. The opening shall include a vapor seal at shaft penetration. Flush mounted, hinged access doors constructed of clear PVC are provided with pawl latches.

C. Tank Mixer
1. The tank mixer shall be gear drive, 400 RPM angle mounted on tank cover. The single impeller shall be a high efficiency axial flow A310 design constructed of T316 SS, mounted with a minimum 3/4" diameter shaft and shall provide an impeller depth 1 1/2 impeller diameters off of tank bottom.
2. The mixer motor shall be high efficiency, low temperature rise, 120 VAC, 1750

RPM with a TEFC enclosure.

3. The mixer shall incorporate oversized bearings rated at a minimum of 100,000 L-10 hours.

D. pH Sensors

1. Reaction tank and effluent pH sensors shall be durable Ryton body with twist lock connector. Flat surface electrode with porous UHMW polyethylene reference junction and glass sensing element. Includes PT1000 integral temperature compensation sensor. Each sensor includes a twist-lock preamplifier with digital (S3L) output.
2. Each sensor includes Burt Process QuickTwist connection for ease of removal for maintenance.
3. Each unit includes sensor-mounted transmitter, NEMA 4X/IP65 with shatterproof glass, backlit LCD display and 4-20mA output with selectable error mode.
4. The reaction tank pH probe shall be mounted on top of the reaction tank. The effluent probe shall be mounted in an effluent U-trap.

E. Reagent Tanks

1. Two twenty gallon nominal capacity reagent tanks constructed of polyethylene with a fiberglass wrap shall be provided. Each tank shall include a gasketed polypropylene cover designed for mounting of chemical metering pumps and a low level liquid sensor. The cover shall have a 2" capped opening for addition of chemicals by a drum transfer pump (optional). A high level float indicator is also included to prevent over-filling of the reagent tank. Each reagent tank shall fit inside a secondary containment tank. A clear PVC hinged cover is provided to cover tank and metering pump for ease of maintenance and operator safety.

F. Reagent Tank Low Level Control

1. Each reagent tank shall be fitted with a low level control switch mounted to the tank cover. When the tank level reaches 6" from tank bottom a signal is sent to the main control panel for audible and visual indication of low reagent level. All liquid level controls shall be float/magnetic reed switch style constructed of polypropylene with a totally encapsulated CPVC stem and a NEMA 4X enclosure. Models shall be Burt Process LSF series.

G. Chemical Metering Pumps

1. Two chemical metering pumps shall be electronic, positive displacement diaphragm type with adjustable stroke length adjustment and variable stroke rate. Pumps shall be equipped with automatic external control by 4-20mA inputs, auto/off/manual selector switch, and circuit breaker reset. Materials of construction of head and fittings are PVC, diaphragm is Teflon faced Hypalon, seat and O-ring are Teflon with ceramic ball.
2. Accessories include injection/anti-siphon/back pressure valve with tubing, foot valve and strainer. The flow rate shall not exceed 0-10 GPH @ 0-35 psig.

H. Control Panel and Components

1. The panel components shall include the following: Control panel shall be NEMA 12 construction and integral to unit. Panel shall be prewired, preassembled and tested prior to delivery to site. Panel shall conform to and include the following:
   a. 120VAC, 60Hz, suitably protected design feed.

b. Keyed control power off/on switch and lamp.
c. Emergency stop button
d. Audible alarm horn.
e. Signet multi-parameter controller for in-tank pH control and effluent monitoring.
f. Route wiring for the installation of subcontractor's connections to identified, adequately rated, enclosed terminal strips.
g. Segregate control voltage wiring and terminals from line voltage wiring and terminals with a grounded separation barrier.
h. Individually fuse devices using blown fuse indicating fusible terminal blocks.
i. Panel face shall include engraved legends for each instrument/operator.

I. pH Recorder
1. Honeywell circular chart recorder, dual pen, DR4300 series, with 4-20mA input signal for effluent pH recording. Chart shall be factory configured for 7 day chart rotation.
2. The system supplier shall provide a 6-month supply of chart paper.

J. Installation
1. All components and instrumentation for the treatment system shall be furnished, ready for installation from a single system supplier.
2. The neutralization system shall be installed in strict accordance with suppliers/manufacturer's recommendations and drawings and in compliance with job specifications, local plumbing codes, local and NEC electrical requirements.
3. System calibration and start-up shall be included in the package provided by the manufacturer. The manufacturer shall also be responsible for conducting a training seminar for the site facilities people prior to the system being turned over to the owner. (Minimum 8 hours total).
4. The manufacturer shall supply a complete set of installation drawings in AutoCAD format showing electrical and plumbing schematics.
5. The manufacturer shall provide three sets of complete bound Installation, Operation and Maintenance Manuals, including component maintenance instructions, system drawings, recommended spare parts, and trouble-shooting guide.
6. The system supplier must have a minimum of ten years experience in the design, manufacture, and installation of pH Neutralization Systems.
7. Reagent chemicals for system operation shall be 50% sulfuric acid and 50% sodium hydroxide. Reagent chemicals for system start-up shall be supplied by the contractor.
8. Plumbing contractor (not the system supplier) shall be responsible for the transfer of reagent chemicals to the reagent tanks. This transfer shall be accomplished using a chemical transfer kit, which may be optionally purchased and includes; face shield, apron, gloves, transfer pump, and hose.

K. Warranty
1. All new components and instrumentation for the neutralization system shall be warranted against defects in workmanship and material for a period of one year from the date of shipment.

L. Insurance
   1. Manufacturer shall include a Certificate of Insurance with their submittal approving that they are insured as a supplier and manufacturer of such systems.

M. Maintenance
   1. Manufacturer shall be capable of providing a maintenance agreement with the system owner should the owner wish to enter into such an agreement.

2.34 PLUMBING FIXTURES

A. Furnish and install all fixtures including supports, connections, fittings and any incidentals to make a complete installation.

B. Supply escutcheons which are not furnished with plumbing fixtures.

C. Faucets and all exposed fittings shall be chromium-plated. All sinks (not lavatories) shall have flow restrictors for a maximum flow of 1.5 GPM.

D. Fixtures shall bear manufacturer's guarantee label or trademark indicating "first quality." Acid-resisting enameled ware shall bear the manufacturer's symbol signifying acid-resisting material.

E. Architect shall be final judge as to whether fixtures fulfill the requirements of the Specifications and as to whether they are of suitable quality.

F. Manufacturer - Fixtures shall be Kohler, American Standard or Toto. Flush valves to be Toto, Sloan-Royal or Delaney Flush Valve Company. Toilet seats to be Church, Beneke or Bemis. Carriers and drainage fittings to be J.R. Smith, Zurn or Josam.

G. The color of all fixtures shall be white.

H. Fixtures shall be in accordance with the following schedule:

<u>P-1 Water Closet</u> (Wall-Hung)
Kohler K4325, vitreous china, 1.28 gallon flush, siphon jet, elongated bowl, wall hung with 1-1/2" top spud.
Church 9500C white, solid plastic, open front seat, no cover, check hinge.
Sloan Royal "Optima" 111-1.28-ES-S flush valve, 1 inch screwdriver angle stop, vacuum breaker, cast brass set screw flange and C.P. I.P.S. nipple to wall and El-154 Transformer. Wiring between flush valve and transformer is the responsibility of the Plumbing Subcontractor, including box for valve connection.
Unit shall be set on an adjustable type combination fixture support and drainage fitting with foot support of type suitable to meet building construction and to set rim at 15" above floor.

<u>P-1H Water Closet</u> (Handicapped)
To be the same as Fixture P-1 outlined above, but to be mounted 17" to the rim of the fixture.

P-1K Water Closet (Pre-K)
Kohler K-4321Vitreous china, 1.6 gallon flush, siphon jet, elongated bowl, floor mounted, 1-1/2" top spud.
K-4686 white, open front seat, scalloped handhold locations.
Sloan Royal "Optima" 111-1.6 ES-S TMO flush valve, 1 inch screwdriver angle stop, vacuum breaker, cast brass set screw flange and C.P.I.P. nipple to wall and EI-154transformer. Wiring between flush valve and transformer is the responsibility of the Plumbing Sub-contractor, including box for valve connection.

P-2 Waterless Urinal
Kohler K-4918 "Steward" vitreous china, wall hung, urinal with removable strainer and with 2 inch wall outlet. This is a proprietary item and no substitutes will be accepted.
Mounted on floor-mounted chair carrier with foot support so rim is 24" above floor.

P-2H Waterless Urinal (Handicapped)
Urinal shall be the same as specified for Fixture P-2 except that mounting shall be 16 inches floor to rim and unit shall be set on a concealed chair carrier with foot support.

P-3 Lavatory
Kohler K-2030 "Greenwich" 20x18 inch vitreous china lavatory with front overflow, 8" faucet centers. Set on floor-mounted arm chair carrier so unit is 32" above floor to rim.
Chicago No. 116.101.AB.1 faucet with deck plate and 240.631.00.1 transformer. Wiring between faucet and transformer is the responsibility of the Plumbing Subcontractor.
K-7715 C.P. drain with integral grid strainer.
K-7607 (Pr) C.P. 3/8-inch angle supplies, with loose key stops, risers.
Powers Model e480 mixing valve with in-line checks installed in the supplies to the faucet fitting.
K-9010 C.P. 1-1/4 inch by 1-1/2 inch cast brass one-piece P-trap with cleanout.
K-9015 C.P. 1-1/2 inch by 6-inch IPS nipple to wall with cast brass set screw flange.

P-3H Lavatory (Handicapped)
Kohler K-2030 "Greenwich" 20 x 18 vitreous china lavatory, with floor-mounted concealed arm type carrier to set unit at 32" above floor.
Chicago No. 116.101.AB.1 faucet with deck plate and transformer. Wiring between faucet and transformer is the responsibility of the Plumbing Subcontractor.
K-13885 C.P. 1-1/4 inch offset drain with integral grid strainer.
K-7607 (Pr) C.P. 3/8-inch angle supplies, with loose key stops, risers.
Power Model e480 mixing valve with in-line checks installed in the supplies to the faucet fitting.
K-9010 C.P. 1-1/4 inch by 1-1/2 inch cast brass one-piece P-trap with cleanout.
K-9015 C.P. 1-1/2 inch by 6-inch IPS nipple to wall with cast brass set screw flange.
Concealed arm chair carrier with steel plate feet welded to uprights with one-piece threaded concealed arms.
All trim under lavatory to be insulated. See Paragraph 2.8.

P-3K Lavatory (Pre-K)
Unit shall be same as P-3H, but shall be mounted for Pre- Kindergarten use, as indicated on Architectural drawings.

P-4 Water Cooler (Handicapper)

Halsey-Taylor Model HTHB-HACG8PV-WF, Filtered single HAC green cooler with hydro-boost, bottle filler. Provide replacement filters 3 pack model number 55898C.
Two (2) 1-1/2 inch brass P-traps.
Two (2) 3/8-inch supplies with stops.
Provide mounting brackets.

P-4A Bi-Level Water Cooler (Handicapped)
Halsey-Taylor Model HTHB-HACG8BLPV-WF, Filtered Bi-Level HAC green cooler with hydro-boost, bottle filler. Provide replacement filters 3 pack model number 55898C.
Two (2) 1-1/2 inch brass P-traps.
Two (2) 3/8-inch supplies with stops.
Provide mounting brackets.

P-4B Drinking Fountain (Support/Storage/Restroom Facility Building)
Halsey Taylor Model 4705, standard finish “Evergreen” textured powder-coat Endura II.
1-1/4” drain outlet.
3/8” supply and stop.

P-5 Shower Units (Typical)
Shower valve/head assembly shall be a Symmons No. 1-100-X shower control with an 4-231- 1.5 GPM shower head. Shower basin to be Fait Products model 36- MFT 36” X 36” Pre-Cast Terrazzo. 2” stainless steel drain body cast integral with removable strainer plate made of stainless steel. Plumbing Subcontractor to set basin and drain.

P-5H Shower Unit (Handicapped)
Shower basin to be constructed in place by the General Contractor. Plumbing Subcontractor to provide floor drain type “A” in each basin. Unit to have Symmons No. 1-25VT-FSB-X-48, pressure balanced shower valve with open-flow hand spray having 5'-0" of hose and 36-inch C.P. bar with adjustable slide and wall connection flange having a vacuum breakers. A 1.5 GPM glow restrictor shall be provided in the spray head.

P-5A Shower Unit (Handicapped)
Shower basin to be constructed in place by the General Contractor. Plumbing Subcontractor to provide floor drain type “A” in each basin. Unit to have Symmons No. 1-25VT-FSB-X-48, pressure balanced shower valve with open-flow hand spray having 5'-0" of hose and 36-inch C.P. bar with adjustable slide and wall connection flange having a vacuum breakers. A 1.5 GPM glow restrictor shall be provided in the spray head.

P-6 Service Sink
American Standard Model Akron 7695.008, enameled cast iron, wall hanger and trim guard, drilled for 8” center faucet.
C.P. 3/8-inch angle supplies with stops.
C.P. 1-1/2” inch cast brass adjustable P-trap with cleanout plug and C.P. cover tube.
Chicago Faucet C.P. Model 305-VBRCF type faucet with swing spout and spray.

P-7 Sink – (Stainless Steel)
Elkay Model LRAD-1919, single compartment, 5-1/2" deep, drilled for 8” faucet, self-rimming, Type 302, 18-8 stainless steel with sound deadening.
LK-35 stainless steel cup strainer and tailpiece.

C.P. 3/8 inch angle supplies with stops.
C.P. 1-1/2 inch cast brass adjustable P-trap with cleanout plug and C.P. cover tube.
Sink to have J.R. Smith solid interceptor Model No. 8710, or equal.
Chicago Faucet Model 2300-8E34ABCP type faucet with swing spout, 1.5 GPM aerator, and ceramic operating cartridge.

P-8 Mop Receptor
Fiat Mop Receptor Model TSB-3003, Terrazzo mop service basin with 6" drop front and stainless steel caps on all curbs.
Chicago No. 445-897-SRCXKCP manual faucet, wall mounted, adjustable arm, rigid vacuum breaker spout with 3/8" male hose thread and pail hook.
#832-AA hose and hose bracket.
#889-CC mop hanger.
Trap to suit.

P-9 Emergency Shower/Eyewash
Shower and Eye Wash units shall be equal to Guardian Model GBF2150, This Contractor shall furnish and install all piping between actuating arm, eyewash and shower head. Pipe to run in walls and above ceilings.

P-9A Acid Room Eyewash
Eyewash unit shall be equal to Guardian Model G 1750 BC. This contractor shall furnish and install all piping associated with unit.

P-10 Sink
Elkay Model LRAD-2219, single compartment, 5-1/2" deep, 18 gauge sink, drilled for 8" center faucet. Unit to have stainless steel cup strainer and tailpiece.
C.P. 3/8-inch angle supplies with stops.
C.P. 1-1/2" inch cast brass adjustable P-trap with cleanout plug and C.P. cover tube.
Chicago Faucet C.P. Model 1888-ABCP type faucet with swing spout. 317-4 inch wrist blade handles.

P-10H Sink
Elkay Model DLR-221910, single compartment, 5- deep, 18 gauge sink, drilled for 8" center faucet. Unit to have stainless steel cup strainer and tailpiece.
C.P. 3/8-inch angle supplies with stops.
C.P. 1-1/2" inch cast brass adjustable P-trap with cleanout plug and C.P. cover tube with offset for H.C.
Chicago Faucet C.P. Model 1888 ABCP type faucet with swing spout, 317 – 4 inch wrist blade handles.

P-11 Washer Connection
Water connection shall be equal to Symmons Model No. W-602.

P-12 Sink
Elkay Model LRAD-2219, single compartment, 5-1/2" deep, 18 gauge sink, drilled for 8" center faucet. Unit to have stainless steel cup strainer and tailpiece.
C.P. 3/8-inch angle supplies with stops.
C.P. 1-1/2" inch cast brass adjustable P-trap with cleanout plug and C.P. cover tube.
Chicago Faucet C.P. Model 786-E3-319ABCP type faucet with swing spout, 2.2 GPM, 6 inch elbow blade handles.

P-13 Sink
Elkay Lustertone Model DRKRQ2220, single compartment, 22” x 19-1/2”, 5" deep, 20 gauge sink, drilled for 8” center faucet no bubbler or hole required. Offset drain hole. Unit to have stainless steel grid strainer and tailpiece.
C.P. 3/8-inch angle supplies with stops.
C.P. 1-1/2” inch cast brass adjustable P-trap with cleanout plug and C.P. cover tube.
Chicago Electronic Faucet C.P. Model 116.103.AB.1 type faucet, 2.2 GPM insert, with deck plate 240.628.21.1, 240.631.00.1 transformer.
One hole to be provide with chrome plug.

P-14 Scrub Sink
Elkay Model EWS3120W6Cstainless steel scrub-up sink with 1-3/4” radius vertical and horizontal coved corners. 1-1/2” rolled rim. Full length 6” high back-splash. Exposed surfaces are hand blended to uniform lustrous satin finish. Underside sound deadened. Furnished with wall hanger and stainless steel support brackets.
LK940GN05T6H, chrome plated mixing faucet with 6” wrist blade handles, swing 5” high gooseneck spout, vandal-resistant, anti-hose aerator.
LK18B, stainless steel perforated strainer grid, 1-1/2” O.D. X 4” stainless steel tailpiece.
C.P. 3/8-inch angle supplies with stops.
C.P. 1-1/2” inch cast brass adjustable P-trap with cleanout plug and C.P. cover tube.

P-15 Sink
Elkay Model LR2922, double compartment, 29” x 22- 7-5/8" deep, 18 gauge sink, drilled for 8” center faucet. Unit to have stainless steel cup strainer LR 35 and tailpiece.
C.P. 3/8-inch angle supplies with stops.
C.P. 1-1/2” inch cast brass adjustable P-trap with cleanout plug and C.P. cover tube.
Chicago Faucet C.P. Model 1102-317ABCP type faucet with swing spout and side spray. 2.2 GPM.

P-16 Styling Wet Station (Black)
Cabinet Model CC-CS10-CS11B.
Collins sink Model CB20, heart-shaped ABS plastic shampoo bowl with 523 metal single-handle faucet, spray hose, vacuum breaker. Drain assembly, mounting bracket, hair strainer.
Powers Series LFe480 tempering valve.
C.P. 3/8-inch angle supplies with stops.
CB21 one piece p-trap.

P-17 Pedestal Shampoo Unit
Collins Model 3337-16, Cameo Add- On Shampoo Station Pedestal shampoo unit with CB87 tilting bowl (Black), unit is free standing with plumbing from the rear with plumbing access door in front.
570 faucet & 388 vacuum breaker, 561 spray hose, vacuum breaker with anti-siphoning back flow preventer.
662S Drain assembly, flexible drain line P/N 20129, mounting bracket, hair strainer
Powers Series LFe480 tempering valve.
C.P. 3/8-inch angle supplies with stops.
CB21 one piece p-trap.

P-17A Pedestal Shampoo Unit
Collins Model 3337-16, Cameo Add- On Shampoo Station Pedestal shampoo unit with CB87 tilting bowl (White), unit is free standing with plumbing from the rear with

plumbing access door in front.
570 faucet & 388 vacuum breaker, 561 spray hose, vacuum breaker with anti-siphoning back flow preventer.
662S Drain assembly, flexible drain line P/N 20129, mounting bracket, hair strainer
Powers Series LFe480 tempering valve.
C.P. 3/8-inch angle supplies with stops.
Piping from the unit will be connected to the building acid waste system and all waste and vent piping from unit will match the systems acid waste material.

P-18 Sink
Elkay Model LRAD-2219, single compartment, 6" deep, 18 gauge sink, drilled for 8" center faucet. Unit to have stainless steel cup strainer and tailpiece.
C.P. 3/8-inch angle supplies with stops.
C.P. 1-1/2" inch cast brass adjustable P-trap with cleanout plug and C.P. cover tube.
Chicago Faucet C.P. Model 786-E3-319ABCP type faucet with swing spout.
Guardian Model G1805 eyewash deck mounted auto-flow 90 degree right hand mounting.
TMV G3600 thermostatic mixing valve.

P-19 and P-19H Science Room Sinks
The countertop, with sink, faucet and drain provide by General Contractor. The sinks will be installed by the General Contractor. This Contractor shall install faucet, drain, trap and all related incidentals. Trap shall be of the same materials as the acid waste system and shall be purchased from the supplier of that system.

P-20 Ceramic and Art Room Sinks
The sink, two (2) faucets and drain provide by General Contractor. This Contractor shall install sink, faucets, drain, trap and all related incidentals. Traps shall be furnished and installed by this Contractor. Sink to have J.R. Smith solid interceptor Model No. 8710, or equal.

P-20H Ceramic and Art Room Sinks (Handicapped)
The sink, faucet and drain provided by General Contractor. This Contractor shall install sink, faucet, drain, trap and all related incidentals. Trap shall be furnished and installed by this Contractor. Sink to have J.R. Smith solid interceptor Model No. 8710, or equal.
All trim under sink to be insulated. See Paragraph 2.8. Drain shall run parallel and tight to wall.

P-21 Whirlpool Connection
Chicago No. 886-CP Wall mounted faucet, adjustable arms, L type swing spout with atmospheric vacuum breaker, vandal proof lever handles. Chicago No. 83, flexible stainless steel hose, 3/8 inch male inlet and outlet, 36 inch.

I. All fixtures and equipment shall be supported and fastened in a satisfactory manner. Where wall-hung fixtures are secured to masonry, they shall be fastened with 1/4-inch through bolts provided with nuts and washers and plates at back, except where chair carriers are specified. Bolt heads and nuts shall be hexagon and exposed bolts, nuts, washers and screws shall be chromium-plated brass. Where secured to concrete walls, they shall be fastened with brass bolts or machine screws in lead sleeve-type expansion shields and shall extend at least 3 inches into solid concrete.

J. Where chair carriers are required, they shall be completely concealed in the building construction and shall rigidly support the fixtures from the floor. Chair carriers shall be securely fastened to the floor and be adjustable both vertically and horizontally, and shall support fixtures in such a manner that no part of the fixture will be supported by the wall or partition. All wall-hung water closets and urinals shall be supported on combination wall-hung drainage fittings and chair carrier complete with foot. These fittings shall be cast iron, vertical or horizontal type, fitted with face plate of the proper type to accommodate the fixture specified, furnished complete with necessary bolts, nuts and washers as well as connecting nipples of the proper length with gaskets for the closet connections.

2.35 HEAT MAINTENANCE CABLE

A. This Contractor shall furnish and install heat maintenance cable on the hot water piping at the following locations as indicated on the drawings. :

B. Heating Cable shall be equal to Raychem “HWAT-Y2 Trace” as manufactured by Tyco Thermal Controls. Cable shall be installed tight to the pipe, below the insulation and in accordance with manufacturer’s recommendations. Cable shall be set to maintain 120º F water temperature using a Raychem *ECO Controller. All cables shall be connected to power supplies at the junction boxes indicated on the electrical plans.

C. Heat tracing shall be provided on the underside of all roof drain bodies of drains which are outside the building envelope and on the associated storm to a point 4”-0” with the building. Heat tracing shall be equal to Raychen “QTVR” self-regulating cable. Cable shall be installed tight to the pipe below the insulation and installed in accordance with manufacturer’s recommendations. Cable shall be set to operate when temperature is below 40°F with a compatible controller. All cables shall be connected to power supplies at the junction boxes indicated on the electrical plans.

2.36 RECYCLED WATER SYSTEM

A. This Section includes a packaged commercial water reclamation system. System shall consist of duplex submersible transfer pump package, vortex downspout separators, and turnkey system for disinfection and repressurization, as indicated on the drawings. System shall ensure output water and tank disinfection 5 micron auto backwashing filter and 254nmλ germicidal ultraviolet lamps. Repressurization equipment shall include 5 Hp onboard pump and 80 gallon ASME bladder tank with pressure switch for system activation and suction strainer assembly with check (foot) valve totalizing water meter with remote register. System shall alternate between delivery mode and programmable tank circulation mode, based on pressure switch signal. System shall be skid-mounted and include a potable water bypass system to ensure continuous supply of water during low-tank, low-UV disinfection, loss of pump prime, or blocked filter situations. On-board control panel shall include system status indicators and alarms, with dry contacts for alarm connection to building control systems.

B. Submittals
1. Product Data: Include rated operating characteristics, furnished specialties, and accessories for each type of product indicated.
2. Shop Drawings: Include plans, sections, details (including dimensions and connection sizes), and attachments to other work.

3. Wiring Diagrams: Power, signal, and external control wiring.
4. Operation and maintenance data.
5. Copy of Comm of Mass Plumbing Board Product Approval listing
6. Warranty: Special warranty specified in this Section.

C. Quality Assurance
1. Electrical Components, Devices, and Accessories: Systems shall be ETL approved for both US and Canada. All applicable electrical components shall be UL listed.
2. Output Water Quality: Meets basic "Urban Reuse" reclaimed water quality levels as defined in 2004 USEPA document, "Guidelines for Water Reuse," table 4-13 (p. 167).

D. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace equipment that fails in materials or workmanship within specified warranty period.
2. Limited Warranty Period: 1 year from date of system startup. Consult operations manual for full warranty details.

E**.** Packaged Water Reclamation Skid System

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Experience: The manufacturer shall have more than five years experience with water filtration, treatment, and pumping systems.
   b. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
      1. Water Control Corporation (Ramsey, MN) model **RW-UV-80 Modified** Approved Equal.
      2. The same manufacturer shall be used for the complete system including UV assembly, filtration equipment, pumps, skid, (tank), and tank components.

F. System Construction
1. The water reclamation system shall consist of quantity 2 (two) X 254nmλ germicidal ultraviolet lamp(s), on-board 5 hp combination pressure/ circulation pump capable of 80 gpm @ 50 psi with programmable timer, 5 micron stainless steel auto-backwashing filter, 3-way motorized diverter valves to alternate between delivery and circulation modes, normally open motorized potable water bypass valve, 80 gallon ASME bladder tank, pressure switch, control panel with LED system status indicators in NEMA 3R enclosure, totalizing water meter with remote register, food-grade dye injector pump, and sampling cocks, all mounted on powder-coated aluminum skid.

G. Mechanical Features
1. The water reclamation system shall disinfect stored water via alternating on-demand/side stream circulation flow through 5 micron auto-backwashing filter and 254nmλ germicidal ultraviolet lamp(s). Water shall be drawn from tank, into skid system. After passing through filter housing and ultraviolet lamp(s), water shall be either sent to fixtures/appliances where usage is occurring – or returned to cistern tank via circulation return line. UVX

radiometer(s) mounted in UV lamp housing(s) shall take constant measurement of UV intensity levels (mW/cm2) to ensure standard UV dose of 20 mJ/cm2 and absolute minimum dose of 10 mJ/cm2. UV intensity levels shall be displayed on control panel digital display. Clean, disinfected water shall be supplied to fixtures and equipment from on-board bladder tank. As tank pressure is depleted, open pressure switch shall send signal for system to switch from circulation to delivery mode. Once pressure switch is satisfied (closed) system shall switch back to timed circulation mode.

H. Connections

1. All piping to and from cistern tanks and water reclamation skid system shall be Schedule 80 PVC, with exception of potable water bypass valve inlet, which shall be piped in Type (M or L) copper. Contractor to provide full-size reduced pressure zone assembly backflow preventer for any potable water connections. See drawings for connection sizes and locations.

I. Controls And Fail-Safe Mechanisms

1. System shall include on-board electronic controller in NEMA 3R enclosure, with LED system and tank status displays. Controller shall monitor at all times tank water level, UV intensity levels, pump temperature, and pressure differential through filter housing(s). Should tank water level drop to suction inlet level, controller shall initiate potable water bypass (via normally open, motorized valve). Recirculation system shall come online at a programmable interval to disinfect remaining tank water. Should UV intesity levels drop such that UV dosage has fallen to 10 mJ/cm2 or lower, controller shall initiate potable water bypass and activate recirculation system through filter array to improve water clarity – or alternatively, allow maintenance staff to replace UV bulb or clean biofilm from bulb via integral cleaner slide. Should pressure differential through filter array exceed 9 psi, controller shall initiate potable water bypass and notify staff that filter requires sirvice. Controller shall also monitor pump temperatures to indicate when pumps require re-priming. Potable water bypass shall be initiated should pump(s) become overheated. Status of all fail-safe functions shall be clearly displayed on LED control panel. System shall include fail-safe alarm light with dry contacts for connection to building monitoring system. Flow rates shall be restricted (via inline outlet flow restrictor) to maximum rated gpm at 40 psi in order to assure adequate single pass UV contact time for disinfection.

J. Accessories

1. Water storage (cistern) tank: System shall include a quantity of 1 (one) below grade cistern tanks. Tank(s) shall have capacity of 20,000gal Tanks shall be watertight, constructed of single-wall fiberglass with interior vinyl-ester liner and rated for potable water storage. Tanks shall include top manhole(s), as well as adequate tappings for full-size overflow, suction outlet, rainwater inlet, and recirculation return. Tank to include all required ballasting hardware. Consult system manufacturer to determine optimal tapping locations.
2. Duplex submersible pump package with controls rated for 80gpm (ea) at 20 ft/hd appropriate to deliver water from storage tank to treatment skid. Pump package to include mounting rails and all tank level controls wired to communicate to skid control panel.

3. Simplex, stainless steel variable speed booster pump and controls (remotely mounted) to supplement discharge pressure to building when system is delivering reclaimed rainwater water Pump to be rated for 100gpm at 30psi.
4. Vortex downspout separators: System shall include a quantity of one (1) Downspout Separator, as indicated on drawings for dirt, moss, leaves, and other debris from drainage effluent.
5. Ultrasonic tank level sensor: System shall include ultrasonic tank level sensor system to monitor cistern water levels (replaces float switch system). Ultrasonic tank level sensor system shall include LED level meter and be designed to operate at a depth of up to (10'/ 26').
6. Water flow sensor/ totalizer. System shall include in-line flow sensor with digital display of both current GPM flow and total gallons used.
7. Injector pump: system shall include on-board chemical injector pump, with chemical level monitor, to inject food grade blue dye into system output (product) water.

K. Installation
1. Install water reclamation system according to the drawings and the manufacturer's instructions. The installer shall be responsible for providing a functional system, installed in accordance with applicable national and local requirements.
2. Install and secure cistern tanks per manufacturers' instructions. Consult manufacturer to determine optimal inlet/outlet connection locations. Above ground tanks shall be mounted on poured concrete base. Tank overflow(s) shall run to storm sewer/grade per civil engineer instructions.
3. Install any vortex separator on down-pipes per manufacturer's instructions. Vortex separators shall be located below grade/suspended from down-pipes with factory supplied mount or adequate pipe hangar support. Direct vortex separator effluent to storm sewer/ to external downspout nozzle for ejection to grade.
4. Install sanitation and repressurization system for harvested water. Install skid system on concrete pad in mechanical room or other location providing protection from freezing and other harmful elements.
5. Connect bladder tank to system outlet via (supplied) PVC socket connection.
6. Connect system outlet to fixtures and/or equipment using Schedule 80 PVC.
7. Connect suction strainer to tank outlet on inside of tank, with check (foot) valve located on exterior side of tank outlet. Suction strainer should be minimum 6" from tank bottom, where possible. Where necessary, consult manufacturer to determine optimal configuration.
8. Connect system suction inlets to suction strainer outlet to cistern tank using Schedule 80 PVC.
9. Tether tank float to tank top per manufacturer's instructions. (Install ultrasonic tank level meter per manufacturer's instructions).
10. Electrical Connections and Grounding: System requires two (2) separate sources of power;
    a. (240/460 Volts 1 or 3) Phase power for the pump.
    b. 120 Volts single phase for the System Control and Disinfection apparatus.
11. Power lines shall be supplied from a building service box, which includes proper connections and circuit breakers with quick disconnection mechanism, and sized according to system requirements (see drawings). Wiring shall conform to local electrical codes and requirements and must be performed by a licensed electrical contractor. Electrical inspection shall be

performed, and inspection notice approved, by an authorized approval agency.

12. Authorized factory representative shall perform final (on-site) system activation, calibration, and training.

L. Field Quality Control

1. Verification: Authorized factory representative shall provide final inspection and verification of system installation and operation.

M. Underground Tank (20,000 Gallons)

The contractor shall provide a single-wall fiberglass reinforced plastic (FRP) water storage tank as shown on the drawings. The water tank shall be manufactured according to applicable American National Standards Institute (ANSI) and American Water works association (AWWA) standards. The tank size, fittings and accessories shall be as shown on the drawings. The fiberglass water tank shall be manufactured by Xerxes Corporation.

Tank to be provided with manway openings to match tank depth with finish grade. Manway to be 22 inch I.D. openings and supplied by tank manufacture. Access risers shall be attached to access openings during tank installation utilizing adhesive or FRP bonding kits as supplied by tank manufacture. Ladders shall be the standard FRP ladders as supplied by tank manufacture.

The tank shall be designed for underground installation, and shall be tested and installed according to the Xerxes Installation Manual and operating Guidelines for Fiberglass underground storage Tanks in effect at the time of installation.

Tank shall be anchored with anchoring straps and shall be FRP anchors as supplied by tank manufacture. Number and location of straps to be coordinated with tank manufacture and structural engineer floatation pad. Prefabricated concrete deadmen, which are designed to ACI Standards 318-11, shall be supplied by the tank manufacture.

2.37 EXTERIOR GREASE INTERCEPTOR #1

A. The Plumbing Subcontractor shall furnish and install, complete in all respects, an exterior grease interceptor constructed and installed as shown on Drawing P2.2. Precast, reinforced concrete unit shall be a 6,000 gallon tank, equal to No. CST-6000, as manufactured by Oldcastle Precast. or equal. Unit shall be of 5,000 psi at 28-day concrete, have a design load of AASHTO-HS20-44, and have steel reinforcement of ASTM A-615, Grade 60. All joints shall be sealed with Acmelite Sealant.

B. Interceptor shall have an inlet, intermediate tees and an outlet tee, all of service weight cast iron. All tees shall extend a minimum of six inches (6”) above the flow line of the tank. Inlet tee shall extend to 34.5” off the bottom, outlet tee shall extend to 12” off the bottom and both shall be on the centerline of the tank, directly below their respective cleanout manholes. This Contractor shall be responsible to install all tees.

C. The interior of the grease interceptor shall have a plasticized liner field applied by this Contractor. Liner shall be equal to Sikagard 62, as manufactured by Sika Corporation and shall be installed in accordance with all the manufacturer’s recommendations.

2.38 EXTERIOR GREASE INTERCEPTOR #2

A. The Plumbing Subcontractor shall furnish and install, complete in all respects, an exterior grease interceptor constructed and installed as shown on Drawing P2.6. Precast, reinforced concrete unit shall be a 2,000 gallon tank. Unit shall be of 5,000 psi at 28-day concrete, have a design load of AASHTO-HS20-44, and have steel reinforcement of ASTM A-615, Grade 60. All joints shall be sealed with Acmelite Sealant.

B. Interceptor shall have an inlet and outlet tee, all of service weight cast iron. All tees shall extend a minimum of six inches (6”) above the flow line of the tank. Inlet tee shall extend to 36” off the bottom, outlet tee shall extend to 12” off the bottom and both shall be on the centerline of the tank, directly below their respective cleanout manholes. This Contractor shall be responsible to install all tees.

C. The interior of the grease interceptor shall have a plasticized liner field applied by this Contractor. Liner shall be equal to Sikagard 62, as manufactured by Sika Corporation and shall be installed in accordance with all the manufacturer’s recommendations

2.39 GAS TRAIN VENT PIPING

A. This Contractor shall be responsible to furnish and install all required gas train vent piping for the boilers and hot water heaters. Piping shall be of same material and supported in the same manner as specified for gas piping. Vent piping shall run from components requiring same to the termination point noted on the drawings. Gas vent piping shall terminate with a turndown elbow with an insect screen.

2.40 COMPRESSED AIR SYSTEMS

A. This Contractor shall furnish and install, complete in all respects, two (2) compressed air systems to serve all locations indicated on the drawings. System shall consist of compressor, air dryer, receiver, distribution piping, filters, regulators, hose reels and quick-disconnect fittings.

B. Air compressor is to be furnished and installed by this Contractor. Air compressor shall be equal to an Ingersoll Rand Model 2545E10-P with a 10 HP, 480 volt, 3 phase compressor with an oil lubricated pump mounted on a 120-gallon, ASME horizontal receiver tank. Unit shall be capable of displacing 35.0 CFM at 175 psi. Tank shall have electric drain valve. This Contractor shall provide a flexible metal hose, approximately 18-inches long on discharge from compressor.

C. Discharge of compressor shall be piped to an air dryer furnished and installed by this Contractor. Unit shall be equal to Model D85HC manufactured by Ingersoll Rand and be capable of handling 50 CFM at 3.44 pressure drop.

D. All wall outlets shall have an air-line filter, regulator and quick-disconnect fitting. Air-line filter shall be equal to Speedaire, heavy duty unit with rugged, die cast metal bowl with sight glass. Regulators shall be equal to a Speedaire, heavy duty unit with solid piston and flat diaphragm. All outlets shall terminate with a quick-disconnect fitting mounted 36-inches above floor with a shut-off valve in the pipe drop at 8'-0" above the floor. Fittings shall be zinc-plated brass. Body size and coupling to be of type as instructed by the Owner.

E. This contractor shall furnish and install all hose reels, where shown on the drawings. Hose reels to be equal to Reelcraft Model A5835-OLPI. Mount reels at 10'-0" above floor. Provide supplemental steel, for mounting.

2.41 GASOLINE INTERCEPTORS

A. Furnish and install a complete precast, concrete gasoline interceptors exactly as detailed on the drawings.

B. Units shall be of precast, reinforced concrete construction. All walls shall have a minimum thickness of five inches (5"). Top of structure shall have a thickness of eight inches (8") and have 24" diameter center opening. Cone section shall vary in thickness from five inches (5") to six inches (6") (bottom to top). Construction of sections shall be in accordance with ASTM C-478 specifications and have a minimum concrete strength of 4,000 psi. All lifting holes shall be filled solid with mortar.

C. All sections shall be sealed with pre-molded "O" ring seals that conform with ASTM 3361 specifications and be non-lubricating and self-adjusting. Seals shall be equal to "Rol N Lok," as manufactured by Nashua Pre-Cast Corporation.

D. Outlet pipe, to a point 5'-0" outside gasoline interceptor, shall be extra heavy cast iron pipe. Penetration shall be sealed with neoprene seals equal to "Rol N Seal," as manufactured by Nashua Pre-Cast Corporation. All pipe connections in cast iron pipe shall be made with lead and oakum joints.

E. Entire interceptor shall be made waterproof with two (2) applications on the exterior and interior of an approved bitumastic compound.

F. Frame and cover shall be equal to LeBaron LK-110 with a weight of 475 pounds, diamond cover with the word "SEWER" cast upon it.

G. Steps in manholes shall be aluminum safety steps equal to WACO F-14-1B or Alcoa R653B. Steps shall be provided at 12" intervals.

2.42 EMERGENCY SHOWER SYSTEM SOLENOID VALVE/TIME CLOCK

A. This contractor shall furnish and install, where shown on the drawings a ball valve with an electric activator unit wired to a digital 24 hour time clock. All items, including time clock and all wiring between activator and time clock is the responsibility of the Plumbing Subcontractor. Unit shall be set to discharge for 10 seconds, every 12 hours. Unit shall be Intermatic Model ET70115C with 10 second momentary output or equal.

2.43 INDUSTRIAL WASTE HOLDING TANK #1

A. This Contractor shall furnish and install, complete in all respects 9,000 gallon, industrial waste holding tank #1 complete with all connections, fittings and monitoring system.

B. This Contractor shall furnish and install a secondary containment liner system (SCLS) within the precast chamber equal to that as manufactured by Miller Environmental, of E. Bridgewater, MA. System shall consist of liner, leak detection system, inspection and alarm standpipes and PVC pump tee. In addition a lid liner with manhole boots shall be provided to enclose the top of the tank.

C. Concrete tank enclosure with manhole to grade shall be furnished and installed by this Contractor. Concrete tank shall be a reinforced concrete unit of dimensions as indicated on the drawings. Unit shall be of 5,000 psi, at 28 day concrete, having a design load of AASHTO-HS20-44 and have steel reinforcement of ASTM A-615-79, Grade 60. All joints shall be sealed with Acmelite Sealant and tank shall be certified water tight. Manhole covers shall be brought up to grade with coarses of sewer brick. Frames shall be set in a full mortar base and sidewalls shall be completely parged.

D. This Contractor shall also furnish and install with the tank an alarm system to activate when the tank is 75% full. Tank sensors shall be an explosion-proof float switch with explosion-proof junction box and conduit and wiring to alarm panel and exterior audio/visual alarms and a push to test and a push to silence button. This Contractor shall be responsible to furnish and install all required components, including sensors for tank, alarm panel, interconnecting wiring, conduit and all related components. Electrical Subcontractor shall only connect 120 volt power to the alarm panel. This contractor shall also furnish and install wiring from a set of contacts, in the control panel, to the MDF Room with an additional 30 ft. of coiled wiring and labeled “Waste Holding Tank”.

E. The Plumbing Subcontractor shall be responsible to file and receive DEP permit for tank installation prior to installing unit.

2.44 INDUSTRIAL WASTE HOLDING TANK #2

A. This contractor shall furnish and install, complete in all respects, an industrial waste holding tank (#2), complete with all connections, fittings and monitoring system.

B. This contractor shall furnish and install a 1,000 gallon, double-walled “Highguard” unit as manufactured by Highland Tank Co. or equal.

C. This Contractor shall also furnish and install with the tank an alarm system to activate when the tank is 75% full. Tank sensors shall be an explosion-proof float switch with explosion-proof junction box and conduit and wiring to alarm panel and exterior audio/visual alarms and a push to test and a push to silence button. This Contractor shall be responsible to furnish and install all required components, including sensors for tank, alarm panel, interconnecting wiring, conduit and all related components. Electrical Subcontractor shall only connect 120 volt power to the alarm panel.

D. The Plumbing Subcontractor shall be responsible to file and receive DEP permit for tank installation prior to installing unit.

2.45 RECYCLED WATER SYSTEM BACK-UP PUMP

A. This contractor shall furnish and install a pre-fabricated and tested single pump, variable speed, packaged pumping system to maintain constant water delivery pressure. The packaged pump system shall be a standard product of a single pump manufacturer. The entire pump system including pump, motor, variable frequency drive and pump controller, shall be designed and built by the same manufacturer. The complete packaged water booster pump system shall be certified and listed by UL (Category QCZJ – Packaged Pumping Systems) for conformance to U.S. and Canadian Standards. The system shall be equal to model CRE64-1-1 Plus, 7.5 HP, 3 X 460 as manufactured by Grundfos Pumps Corporation. System shall have a total capacity of 240 GPM @ 39 feet TDH with a discharge pressure of 62 PSIG with a minimum suction pressure of 50 PSIG.

B. The pumps shall be ANSI/NSF 61 approved for drinking water and shall be of the in-line vertical multi-stage design. The head-capacity curve shall have a steady rise in head from maximum to minimum flow within the preferred operating region. The shut-off head shall be a minimum of 20% higher than the head at the best efficiency point. Pump shall have the following features:

1) The pump impellers shall be secured directly to the smooth pump shaft by means of a split cone and nut design.
2) Pump Construction.

a. Suction/discharge base, pump head	Ductile Iron (ASTM 65-45-12)
b. Shaft couplings, flange rings:	Ductile Iron (ASTM 65-45-12)
b. Shaft	431 Stainless Steel
c. Motor Stool	Cast Iron (ASTM Class 30)
d. Impellers, diffuser chambers, outer sleeve:	304 Stainless Steel
e. Impeller wear rings:	304 Stainless Steel
f. Intermediate Bearing Journals:	Tungsten Carbide
g. Intermediate Chamber Bearings:	Leadless Tin Bronze
h. Chamber Bushings:	Graphite Filled PTFE
I. O-rings:	EPDM

3) The shaft seal shall be a single balanced metal bellows cartridge with the following construction:

a. Bellows:	904L Stainless Steel
b. Shaft Sleeve, Gland Plate, Drive Collar:	316 Stainless Steel
c. Stationary Ring:	Carbon
d. Rotating Ring:	Tungsten Carbide
e. O-rings:	EPDM

4) Shaft seal replacement shall be possible without removal of any pump components other than the coupling guard, motor couplings, motor and seal cover.

C. Motor shall be of the Integrated Variable Frequency Drive design consisting of a motor and a Variable Frequency Drive (VFD) with a built-in pump system controller. The complete VFD/motor assembly shall be built and tested as one unit by the same manufacturer. The VFD/motor shall have an IP55 (TEFC) enclosure rating as a complete assembly. The motor shall have a standard NEMA C-Face, Class F insulation with a Class B temperature rise. The VFD shall be of the PWM (Pulse Width Modulation) design using up to date IGBT (Insulated Gate Bipolar Transistor) technology. The VFD shall convert incoming fixed frequency single-phase AC power into a variable frequency and voltage for controlling the speed of the motor. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump control and to eliminate the need for motor de-rating. The VFD shall have, as a standard component, an RFI filter (Radio Frequency Interference) to minimize electrical noise disturbances between the power electronics and the power supply. The VFD/motor shall meet all requirements of the EMC directive concerning residential and light industry equipment (EN 61800-3). The VFD shall have a minimum of two skip frequency bands which can be field adjustable. The VFD shall have internal solid-state overload protection designed to trip within the range of 125-150% of rated current. The VFD/motor shall include protection against input transients, loss of AC line phase, over-voltage, under-voltage, VFD over-temperature, and motor over-temperature. The motor over-temperature protection shall consist of three series connected PTC thermistors, one for each motor phase. The VFD/motor shall provide full nameplate output capacity (horsepower and speed) within a balanced voltage range of 414 to 528 volts. Automatic De-Rate Function: The VFD/motor shall reduce speed during periods of overload allowing for reduced capacity pump operation without complete shut-down of the system. Detection of

overload shall be based on continuous monitoring of current, voltage and temperature within the VFD/motor assembly. The VFD/motor shall have, as a minimum, the following input/output capabilities:

1) Speed Reference Signal: 0-10 VDC, 4-20mA
2) Digital remote on/off
3) Fault Signal Relay (NC or NO)
4) Fieldbus communication port (RS485)

Motor drive end bearings shall be adequately sized so that the minimum L10 bearing life is 17,500 hours at the minimum allowable continuous flow rate for the pump at full rated speed.

D. The pump system controller (Proportional-Integral) shall be a standard component of the integrated variable frequency drive motor developed and supported by the pump manufacturer. The pump system controller shall have an easy to use interface mounted on the VFD/motor enclosure. Pump system start/stop and set-point adjustment shall be possible through the use of two push buttons located on the drive enclosure. The VFD/motor shall be capable of receiving a remote analog set-point (4-20mA or 0-10 VDC) as well as a remote on/off (digital) signal. Pump status and alarm state shall be indicated via two LED lights located on the VFD/motor enclosure. Advanced programming and troubleshooting shall be possible via an infra-red hand held programmer or a field connected personal computer. Pump system programming (field adjustable) shall include as a minimum the following:

◊ System Pressure set-point, psig
◊ System Stop pressure, psig
◊ Pressure Transducer supply/range
◊ System Time (Proportional Gain)
◊ System start pressure, psig
◊ Minimum Pump Speed, %
◊ Maximum Pump Speed, %
◊ Integral Action Time

The infra-red programmer shall be capable of displaying the following status readings:

◊ Pump Status (on, off, min., max.)
◊ Actual system pressure, psig
◊ Pump speed, rpm
◊ VFD/Motor total cumulative kWh
◊ System Set-point, psig
◊ Remote set-point, %
◊ VFD/Motor input power, kW
◊ VFD/Motor total operating hours

The infra-red programmer shall also be capable of displaying the following alarms, with the last five alarms stored in memory:

◊ Loss of sensor signal
◊ Under-voltage & Over-voltage
◊ Motor over-temperature
◊ Drive Over-current
◊ Loss of external set-point signal
◊ Motor overload (blocked pump)
◊ Drive over-temperature

E. The system controller shall receive an analog signal [4-20mA] from the factory installed pressure transducer on the discharge manifold, indicating the actual system pressure. When a flow demand is detected (system pressure drops below the start pressure) the VFD/motor shall start and increase speed until the actual system pressure matches the system set-point. As flow demand changes (increases or decreases), the speed of the pump shall be adjusted to maintain the system set-point pressure.

If a no flow shut-down is required (periods of zero demand) a bladder type diaphragm tank shall be installed. The tank shall be piped to the discharge manifold or system piping downstream of the pump. When zero flow is detected by the system controller, the pump shall be switched off. When the system pressure drops to the start pressure, (flow begins after shut-down), the pump shall be switched on, increasing speed to maintain the system set-point pressure. Zero flow conditions shall be detected by the system controller/factory installed pressure transmitter without the use of additional flow switches or motor current sensing devices.

F. The system shall have a maximum working pressure of 232 psig at a temperature of 176°F. Isolation valves shall be provided on the suction and discharge of the system and shall be the points of connection to the system piping. Isolation valve sizes 2 inch and smaller shall be nickel plated brass full port ball valves. Isolation valve sizes 3 inch and larger shall be a full lug style butterfly valve. The valve disk shall be of stainless steel. The valve seat material shall be EPDM and the body shall be cast iron, coated internally and externally with fusion-bonded epoxy. A spring-loaded non-slam type check valve shall be installed on the discharge of the pump. The valve shall be a wafer style type fitted between two flanges. The head loss through the valve shall not exceed 5 psi at the pump design capacity. Check valves 1-1/2" and smaller shall have a POM composite body and poppet, a stainless steel spring with EPDM or NBR seats. Check valves 2" and larger shall have a body material of stainless steel or epoxy coated iron (fusion bonded) with an EPDM or NBR resilient seat. Spring material shall be stainless steel. Disk shall be of stainless steel or leadless bronze. For systems that require a diaphragm tank (field installed), a minimum diaphragm tank connection size of ¾" (three quarter inch) shall be provided on the discharge manifold. A pressure transducer shall be factory installed on the discharge manifold (or field installed as specified on plans). Pressure transducers shall be made of 316 stainless steel. Transducer accuracy shall be +/- 1.0% full scale with hysteresis and repeatability of no greater than 0.1% full scale. The output signal shall be 4-20 mA with a supply voltage range of 9-32 VDC. A bourdon tube pressure gauge, 2.5 inch diameter, shall be placed on the suction and discharge manifolds. The gauge shall be liquid filled and have copper alloy internal parts in a stainless steel case. Gauge accuracy shall be 2/1/2 %. The gauge shall be capable of a pressure of 30% above it's maximum span without requiring recalibration. A factory installed pressure switch shall be installed on the suction manifold for water shortage protection. All wetted parts shall be of stainless steel. The pump shut-down pressure shall be 3 psig with a reset pressure of 5 psig. An adjustable pressure switch shall be available as an option. Systems with a flooded suction inlet or suction lift configuration will require a field installed water shortage device. A normally open dry contact shall be available on the VFD/Motor for field installation. The system shall include a factory installed service disconnect switch mounted in a lockable NEMA 4 enclosure.

G. A 132 gallon diaphragm tank shall be mounted on the discharge header. Tank shall be bladder-lined, 150 psi rated ASME certified.

H. The entire pump station shall be factory performance tested as a complete unit prior to shipment. Job-site programming shall be entered into the controller prior to shipment (details of installation requirements shall be communicated to the pump system manufacturer). A verified performance test report shall be made available from the system manufacturer. The system shall undergo a hydrostatic test of 250 psig for a minimum of 15 minutes prior to shipment.

I. The warranty period shall be a non-prorated period of 24 months from date of installation, not to exceed 30 months from date of manufacture. The entire pump station shall be factory performance tested as a complete unit prior to shipment. Job-site programming shall be entered into the controller prior to shipment (details of installation requirements shall be communicated to the pump system manufacturer). A verified performance test report shall be made available from the system manufacturer. The system shall undergo a hydrostatic test of 250 psig for a minimum of 15 minutes prior to shipment.

2.46 VACUUM SYSTEM PUMP

A. This Contractor shall furnish and install an oilless, rotay vane vacuum pump with receiver, control panel and controls. Unit to have capacity of 18 ACFM, be capable of 20" Hg vacuum and have a 60 gallon vertical receiver with control panel and all related controls. Unit shall be Global Vac Model GP-BKS-40-60V or equal. Pipe drain from receiver to floor drain in room.

2.47 SANITARY LIFT STATION

A. This Contractor shall furnish and install, complete in all respects, a lift station, consisting of manhole, pumps, controls, piping and all related components.

B. Manholes

1. Manhole shall be constructed as detailed on Drawing P2.3.
2. Precast manhole sections shall be of reinforced concrete, a minimum of five inches (5") in thickness for barrel sections. The bottom section of all manholes shall be of reinforced concrete with a six inch (6") thick bottom. Concrete shall have a minimum strength of 4000 psi and each section shall meet with ASTM C-478 specifications. Lifting holes shall be filled solid with mortar.
3. Precast manhole sections shall be sealed with pre-molded "O" ring seals and shall conform with ASTM 3361 specifications and be non-lubricating and self-=adjusting. All seals shall be 3equal to "Rol N Lok," as manufactured by Field Pre-Cast Corporation.
4. Pipe seals at precast manholes shall be made with neoprene seals equal to "Kor-N'Seal," as manufactured by Field Pre-Cast Corporation.
5. Manhole shall be made waterproof with two (2) applications on the exterior of an approved bitumastic compound.
6. Manhole frame and cover shall be equal to Neenah Model No. R-6663-DH, with diamond cover design and bolted and sealed lids.
7. Steps in manhole shall be aluminum safety steps equal to WAXO F-14-2-B or Alcoa R653B. Steps shall be provided at twelve inch (12") increments.

C. Duplex Ejector Pump System

1. Furnish and install, as shown on the Drawings, a duplex sewage ejector equal to two (2) Weil Pumps, Series 3-2521-3 heavy duty submersible pumps rated to deliver 75 GPM against a TDH of 35' at 1750 RPM with 2613 removal system. Units to be supplied with 3" discharge pipes and elbows. Pumps to be directly connected to a 3 HP, three phase, 480 volt, 60 Hz, 1750 RPM drip-protected motor.
2. Pumps shall be automatically controlled by a micro-pressure switch arrangement consisting of "pump-off" and "pump-on" switch (which alternates pumps), "standby pump on" switch and "high water alarm" switch. These switches shall be provided with wiring and conduit to an exterior control panel with alternator and fuse3d disconnect switches, all supplied as part of the duplex ejector system by this contractor. Panel shall have additional contacts for connection to the building's alarm system. System shall be completely wired for final connection by Electrical Subcontractor.
3. Discharge piping from pump to building drain, at location shown on drawings, shall be type "K" copper with sweat joints. Shutoff valves in discharge piping shall be equal to Jenkins Figure 240. Pump discharge piping shall be hydrostatically tested to 50 psi for a period of two (2) hours.

2.48 VALVE TAGS, NAMEPLATES AND CHARTS

A. All valves on pipes of every description shall have neat circular brass valve tags of at least 1-1/2 inches in diameter, attached with brass hook to each valve stem. Stamp on these valve tags in letters as large as practical (1/2 inch minimum) the number of the valve and the service, such as "H.W.," "C.W.," for hot water and cold water respectively. The numbers of each service shall be consecutive.

B. All valves on tanks and pumps shall be numbered by 3-inch red metal discs with white numbers 2 inches high secured to stem of valves by means of brass hooks or small solid-link brass chain.

C. These numbers shall correspond to numbers indicated for valves on the RECORD DRAWINGS and on two printed detailed lists. These printed lists shall state the numbers and locations of each valve and the fixture or group of fixtures which it controls, and other necessary information such as requiring the opening or closing of another valve or valves, when any one valve is to be opened or closed.

D. These printed lists shall be prepared in a format to meet approval of the Architect. Lists shall be framed under glass and hung as directed by the Architect.

E. Each water outlet on the water systems shall be additionally tagged as follows: Potable water outlets shall be identified by 3-inch diameter metal tags bearing the legend "SAFE WATER" in letters not less than 1/2-inch in height. Non-potable water outlets shall be identified by firmly-attached metal tags having the shape of a 4-inch equilateral triangle bearing the legend "WATER UNSAFE" in letters not less than 7/16-inch in height.

F. Nameplates, catalog numbers, and rating identification shall be securely attached to electrical and mechanical equipment with screws or rivets. Adhesives or cements will not be permitted.

2.49 PIPE IDENTIFICATION

A. All piping, except recycled water piping, shall have markers applied 25 feet on center and on both sides of wall penetrations and at access panel locations. Recycled water piping shall have markers applied 10-feet on center and on both sides of wall penetrations and at access panel locations. Identification shall be applied after final painting of pipe covering is complete. Identification shall consist of the words “Caution Gray Water System” in 1” high letters of a color sharply contrasting to the purple pipe. Markers shall be applied after final painting of pipe covering is complete. All markers shall indicate direction of flow, description of pipe contents, and shall be of colors as specified herein.

B. All recycled water piping, shall be identified by being totally painted purple, by the painting contractor, as directed by the Massachusetts Plumbing Board. All potable water shall be painted with 3” wide bands at 10’-0” intervals and on both sides of floor and wall penetrations, by the painting contractor.

C. Markers for piping up to six inches in diameter, including covering, shall be equal to Seton Type SNA snap-on markers. Markers for 6-inch diameter and larger, including covering, shall be equal to Seton Type STR strap-on markers with stainless steel spring fasteners. Markers on vertical lines shall be mounted as high as possible.

D. Pipe markers shall be as follows:

Piping System	Marking	Background Color
Non-potable Water	Unsafe Water	Yellow
Domestic Cold Water	Cold Water	Green
Domestic Hot Water	Domestic Hot Water	Green
Domestic Hot Water Return	Domestic Hot Water Return	Green
Waste	Waste	Blue
Vent	Vent	Blue
Storm	Storm	Blue
Gas	Gas	Yellow
Recycled Water	Grey Water	Purple

2.50 WATER TREATMENT

A. The design of the new water treatment system is to mimic the existing school treatment.

B. Treatment to elevating the raw water pH from between a pH of 6.0-6.5 to a pH of 8.0. The system to include three 30-inch diameter, 72-inch high, up flow, calcium carbonate contact fiberglass pressure vessels. The 95% calcium carbonate sarcrificial media will be supported, within the cylinders, by gravel support layer. Designed as an up flow treatment system, backwashing of the media will be required.

B. The design allows for a flow rate of 30 gallons per minute (GPM) for each of the three tanks. A discharge flow rate will be restricted to 30 GPM from each tank with a maximum design flow rate of 90 GPM. The daily monitoring of the finished water pH will govern the need to replenish the calcium carbonate.

PART 3 EXECUTION

3.1 OPERATION AND START-UP

A. This Contractor shall furnish all labor, materials and equipment necessary to place the equipment into operation and then start and operate all systems to demonstrate the fitness of the installation.

B. Prior to start-up, the Plumbing Sub-contractor shall check all systems for completeness, provide lubrication, clean and flush all piping and equipment, perform pressure tests, chemical treatment, and make all other adjustments necessary for start-up.

C. This Contractor may start portions of the systems as the work progresses; however, all systems which are normally operating simultaneously must be so operated upon completion of the work.

3.2 COORDINATION

A. The structure and its appurtenances, clearances and the related systems, such as plumbing, fire protection, heating, ventilation and electric, have been planned to be adequate and suitable for the installation of equipment specified under this Section. The Owner will not assume any increase in cost caused by differing requirements peculiar to a particular make or type of equipment and any such incidental cost shall be borne by this Contractor. He shall be responsible for the proper installation and location of his required sleeves, chases and inserts and see that they are set in the forms before the concrete is poured. He shall be responsible for his work and equipment furnished and installed by him until the completion and final acceptance of this Contract, and he shall replace any work which may be damaged, lost or stolen, without additional cost to the Owner.

B. In the event there is a conflict or inadequate space for the proper installation of Plumbing equipment, this Contractor shall prepare a scaled (1/4" - 1'-0" min.) composite drawing showing the building structure and all equipment and items affecting the installation, to clearly identify the areas of conflict. This Contractor shall submit four (4) copies of the drawing, along with a written explanation of the problem, to the Architect for his review and determination on what action to take to resolve the conflict.

C. It shall be the duty of this Contractor to furnish full information to all trades relative to the work they are to do in connection with work under this Section. This includes data for wiring, including wiring diagrams, equipment foundations, pipe connections and related components. furnished under other Sections.

3.3 PAINTING

A. This Contractor shall apply one (1) coat of anti-rust paint and one (1) coat of flat black enamel to all support steel, hangers and other steel or iron elements of the Plumbing System, furnished by him, which will be enclosed or above ceilings when the project is completed.

B. Paint shall be omitted from all items with a galvanized finish.

C. All surfaces to be painted shall be free of dirt, scale, rust, grease and oil. Rust spots are to be wire brushed. Ambient temperature shall be in accordance with paint manufacturer's requirements when painting is being performed.

D. This Contractor shall touch up, with spray paint, all scratched or damaged surfaces of equipment with factory finish. Spray paint shall be the same color and type as factory finish.

E. The Painting Contractor shall paint all mechanical equipment, enclosures, covers, panels, insulation, conduit and other equipment exposed to view, except factory finished items. Care shall be taken not to paint over equipment nameplates. This Contractor shall leave surfaces to be painted ready to receive paint. The Painting Contractor shall apply paint in accordance with the Painting and Finishing portion of this Specification. Colors shall be selected by the Architect.

3.4 PROTECTION OF SYSTEMS

A. Materials, fixtures and fittings shall be properly protected and all pipe openings shall be temporarily closed so as to prevent obstructions and damage. All plumbing fixtures (i.e., water closets, lavatories, and urinals) shall be boxed over and all other fixtures protected with pasted-on paper. Post notice prohibiting the use of the fixtures prior to completion. Take precaution to protect all materials.

3.5 SANITARY AND STORM DRAINAGE SYSTEMS

A. Sanitary, Waste, Kitchen Waste, Garage Waste, Industrial Waste and Acid Waste Systems
   1. Provide complete interior and exterior sanitary, waste, Kitchen Waste, Garage Waste, Industrial Waste and Acid Waste systems up to 10'-0" off each building, or as indicated on the Drawings, connecting to all plumbing fixtures, floor drains and equipment.

B. Storm
   1. Provide complete storm water piping systems, up to 10'-0" off the building, or as indicated on the drawings, connecting to all roof drains.

C. Indirect Waste Piping Systems
   1. Furnish and install complete indirect waste piping systems, as indicated on the drawings, connecting to fixtures and equipment, discharging through an air gap into trapped floor drains or fixtures.

D. General
   1. Soil, waste, Kitchen Waste, vent, acid waste, acid vent, garage waste, industrial waste and storm piping shall be installed, as indicated on the Drawings, properly secured to the building structure. All piping above slab shall be secured with iron hangers. Extend to roof all lines of soil, waste and vent piping in stacks with all branches and fittings required and with extension through roof, by the Commonwealth of Massachusetts Plumbing Code. Where an end circuit vent pipe from any fixture or line of fixtures is connected to a vent line serving other fixtures, the connection shall be at least three feet (3') or sufficiently above the floor on which the fixtures are located, to prevent use of the vent line as a waste line.
   2. All changes in pipe size and direction on soil connections and waste lines shall be made with Y's and 45-degree fittings or 45-degree combination fittings shall be used wherever possible. All offsets shall be made at an angle of not more than 45 degrees.
   3. All fixtures and drains shall be separately trapped and all traps shall be vented, unless otherwise indicated on the drawings, for fixtures or drains in battery vent systems.
   4. This Contractor shall flush the sanitary and storm system piping with water in sufficient volume to obtain free flow through line. Remove all obstructions and correct all defects discovered.
   5. All cast iron pipes shall be free from sand holes, cracks or other defects and shall be of uniform weight, size and thickness, installed concealed in finished areas, to provide adequate waste from fixtures, evenly pitched and properly secured with iron hangers.
   6. All piping three inches (3") or less in diameter shall be installed with a pitch of not less than 1/4 inch per foot; larger than three inches (3") in diameter

shall be installed with a pitch of not less than 1/8 of an inch per foot.

7. The building drains shall leave the building where shown on the Drawings, and shall be provided with a full four inch (4") cleanout accessible from the building interior.
8. Prior to commencement of work, this Contractor shall verify with the General Contractor all inverts and direction of lines leaving the building.
9. Furnish and install a complete system of vent piping to vent all stacks, fixtures, traps and appliances, as indicated on the Drawings and/or required to meet the Plumbing Code. All vent piping shall be concealed, where possible, with the horizontal pipe pitching back toward fixtures to allow condensation to drain. Vent stacks passing through the roof shall extend 18 inches above the roof, and shall be a minimum size of two inches (2") in diameter. The vent shall be located at least eight feet (8') back of roof edges.

3.6 WATER SYSTEMS

A. Provide complete water systems to service all fixtures, systems, equipment and points requiring water throughout the project. Systems shall include connection to water services, water meters, all valves, all piping, insulation, gauges, treatment system all control devices, equipment bases and all other related controls and accessories specified herein and/or indicated.

B. Installation

1. Branch lines from service or main lines shall be taken off the top of main as indicated, using such cross-over fittings as may be required by structural or installation conditions. All service pipes, fittings and valves shall be kept a sufficient distance from other work and not less than 1/2 inch between finished coverings on the different services.
2. Provide shock absorbers at hot water heaters and at all locations indicated on the Drawings. Provide access panels at all concealed shock absorbers.
3. Pipes shall be run parallel and graded evenly to drainage points. There shall be a 1/2 inch drain valve at each low point in piping so that all parts of the systems can be drawn off.
4. Provide valves on all risers to groups of fixtures and wherever shown on the Drawings. Valves in pipe spaces shall be made accessible by the use of access panels.
5. Cast brass or bronze unions shall be installed in the water system at the connections to all equipment so that they may be conveniently disassembled.
6. Pipe shall be cut accurately to measurements established at the site and shall be worked into place without springing or forcing.
7. Air chambers shall be provided at the top of supplies to each plumbing fixture or series of fixtures, not protected by a shock absorber.
8. No piping shall be installed in a manner to permit back siphonage or any flow of water from sanitary or drainage systems into water service or distribution piping under any conditions.
9. Air gaps, open end of funnel drains and approved vacuum breaking devices shall be provided. Piping to hose end faucets or hose end fittings or any fixtures where water supply outlet is below the fixture overflow rim shall have vacuum breakers.
10. Where flanges are installed on the systems, red rubber gaskets shall be installed between each pair of flanges.

11. Heating of piping to eliminate the installation of fittings will not be permitted.
12. Piping systems shall be kept clean during all phases of work. Open ends of incomplete piping shall be protected to prevent the entrance of foreign materials.
13. Furnish and install a copper-plated friction clamp on all cold water supplies to each water closet.
14. Provide suitable means of thermal expansion for all hot water piping, using swing joints, expansion joints or expansion loops, and long-turn-offsets. Piping connections to equipment shall be provided with unions or flanges to permit alterations and repairs.

3.7 GAS DISTRIBUTION SYSTEMS

A. Provide complete gas distribution systems to service all equipment and points requiring gas throughout the project. System shall include all cooking equipment, boilers, make-up air unit, hot water heaters, science labs and all other equipment specified herein and/or indicated.

B. Installation
1. All gas piping shall be installed in accordance with the rules and regulations of the Massachusetts State Fuel Gas Code.
2. Gas piping shall be supported to pitch evenly toward drip pockets.
3. This Contractor shall be responsible to field paint all exterior gas piping with two (2) coats of grey enamel paint.

3.8 ALTERNATES

A. Refer to ALTERNATES, Section 01 23 00, for alternates affecting the scope of work under this section.

B. The work of this Section, which is required by the scope of work as stated in the ALTERNATES, Section 01 23 00, shall comply with the applicable quality and performance requirements for similar work under this Section.

C. The alternates which effect the Plumbing sections are:
1. Alternate No. 2 – Concession and Restroom Facility
a. Alternate No. 2: All Plumbing System related to the Concession and Restroom Facility, labeled Alternate No. 2 in the Specifications and Drawings.

END OF SECTION

SECTION 23 00 00
HEATING, VENTILATION AND AIR CONDITIONING

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END OF SECTION 164

SECTION 23 00 00

HEATING, VENTILATING AND AIR CONDITIONING

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. The BIDDING REQUIREMENTS, CONTRACT FORMS, and CONTRACT CONDITIONS as listed in the Table of Contents, and applicable parts of Division 1 - GENERAL REQUIREMENTS shall be included in, and made a part of this Section.

B. Work of this Section requires Filed Sub-Bids and is governed by the provisions of the Massachusetts General Laws (MGL), Public Bidding Law - Chapter 149, Sections 44A to 44J inclusive, as amended, and applicable Sections of the MGL, Public Contract Law - Chapter 30.

C. The work to be completed by the Filed Subcontractor for the work of this Section is shown on the following listed Drawings:

Site Work Drawings: L xxx through L xxx inclusive.
Architectural Drawings: A xxx through A xxx inclusive.
Food Service Drawings: K xxx through K xxx inclusive
Structural Drawings: S xxx through S xxx inclusive.
Plumbing Drawings: P xxx through P xxx inclusive.
Fire Protection Drawings: FP xxx through FP xxx inclusive.
HVAC Drawings: H xxx through H xxx inclusive
Electrical Drawings: E xxx through E xxx inclusive.
Telecommunications Drawings: T xxx through T xxx inclusive

1. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section. The listing of Contract Drawings above does not limit Filed Subcontractor's responsibility to determine full extent of work of this Section as required by all Drawings listed in the Drawing List on the Drawing Title Sheet, as modified by Addenda.
2. Refer to Section 01 23 00 - ALTERNATES, for alternates that may affect the scope of Work of this Section.

D. Sub-Bids for work under this Section shall be for the complete work and shall be filed in a sealed envelope with the Awarding Authority at a time and place as stipulated in INVITATION TO BID and INSTRUCTIONS TO BIDDERS.

1. The following shall appear on the upper left hand corner of the envelope:

   NAME OF SUB-BIDDER: _____
   SUB-BID FOR TRADE: TITLE.

2. Each Sub-Bid submittal for work under this Section shall be on forms furnished by Awarding Authority, as bound herein, accompanied with the required bid deposit in compliance with MGL c149, Section 44B in the amount of 5 percent of Filed Sub-Bid.

E. Sub Sub-Bid Requirements: In accordance with Massachusetts General Law, Chapter 149, Section 44F, as amended, The Filed Sub-Bidder shall list in "Form for Sub-Bids" the name and bid price of each person, firm or corporation performing each class of work or part thereof for which the Section of the Specifications for that Sub-Trade require such listing.

1. This filed trade requires that the following classes of work be listed in under the conditions indicated herein.
   a. SHEETMETAL WORK 2.37, 2.38, 3.9
   b. INSULATION 2.24, 2.25, 2.26, 2.27, 3.13
   c. AUTOMATIC TEMPERATURE CONTROLS 2.51

1.2 GENERAL REFERENCES

A. Bidding Requirements, Contract Forms, General and Supplementary Conditions and Division 1, General Requirements are hereby made a part of this Section.

1.3 SCOPE OF WORK

A. Work Included: The scope of work consists of the installation of all materials to be furnished under this SECTION, and without limiting the generality thereof, consists of furnishing all labor, materials, equipment, plant, transportation, rigging, staging, appurtenances and services necessary and/or incidental to properly complete all heating, ventilating and air conditioning work as shown on the Drawings, as described in the Specifications, or as reasonably inferred from either, in the opinion of the Architect as being required, and includes:

1. Gas fired hot water boilers and associated combustion air system and flue system.
2. Hot water heating and chilled water cooling rooftop units and energy recovery units.
3. Hot and chilled water supply and return piping distribution system and accessories.
4. Hot and chilled water circulation pumps, expansion tanks, air separators and accessories.
5. High efficiency air cooled chiller.
6. Supply ductwork with associated terminal boxes, hot water reheats coils and supply registers and diffusers.
8. Return and exhaust ductwork with associated grilles and registers.
9. Refrigerant piping systems and accessories.
10. Radiant panels, fintube radiation, cabinet unit heaters, convectors and horizontal unit heaters.
11. Toilet exhaust and general exhaust systems.
12. Kitchen hood exhaust system.
13. Piping and ductwork insulation.
14. Balancing, air and water.
15. Automatic temperature controls.
16. Chemical treatment.
17. Furnish, erect and maintain staging and scaffolding, including mechanical hoisting and rigging equipment required for the performance of the heating, ventilating and air conditioning work.

B. The HVAC Subcontractor shall be responsible for all cutting and patching related to the work of this Section except in finished surfaces. Patching is the responsibility of the trade affected.
   1. For coordination of cutting and patching, refer to Section 01 31 00, PROJECT MANAGEMENT AND COORDINATION.
   2. For cutting and patching specifications, refer to Section 01 73 00, EXECUTION.

C. Items to be Furnished Only: Furnish the following items for installation by the designated Sections:
   1. Access Panels
      a. Access panels for access to heating, ventilating and air conditioning equipment shall be furnished under this Section for installation by the General Contractor or appropriate Subcontractor.

D. Items to be Installed Only: Install the following items as furnished by the designated Sections:
   1. SECTION 26 00 00 - ELECTRICAL
      a. Duct mounted smoke detectors.

E. Related Work: The following items of work are not included in this Section and are specified under the designated SECTIONS:
   1. DIVISION 1 - GENERAL REQUIREMENTS
      SECTION 01 31 00 PROJECT MANAGEMENT AND COORDINATION
      a. Coordination of cutting and patching.
      SECTION 01 73 00 - CUTTING AND PATCHING
      SECTION 01 91 13 – COMMISSIONING REQUIREMENTS
   2. DIVISION 2 - SITE CONSTRUCTION
      a. Excavation, backfill, pumping and shoring.
   3. DIVISION 3 - CONCRETE
      a. Concrete bases and supports.
   4. DIVISION 7 - THERMAL AND MOISTURE PROTECTION
      SECTION 07 00 02 - ROOFING AND FLASHING
      a. Flashing for all roof penetrations.
   5. DIVISION 8 - DOORS AND WINDOWS
      a. Door louvers and undercut doors.
   6. DIVISION 9 - FINISHES
      SECTION 09 00 09 - PAINTING
      a. Field painting, except as noted otherwise. Field painting of radiation shall be done using the electrostatic method.
   7. DIVISION 8 - OPENINGS
      SECTION 08 90 00 - LOUVERS AND VENTS
      a. Exterior wall louvers.
   8. DIVISION 11 - EQUIPMENT
      SECTION 11 40 00 - FOOD SERVICE EQUIPMENT
      a. Kitchen equipment.
   9. DIVISION 21 - FIRE SUPPRESSION
      SECTION 21 00 00 FIRE SUPPRESSION
      a. Sprinklers and equipment.
   10. DIVISION 22 - PLUMBING
      SECTION 22 00 00 - PLUMBING
      a. Domestic water heaters.

b. Town water make-up.

11. DIVISION 26 - ELECTRICAL
SECTION 26 00 00 - ELECTRICAL
a. Power wiring except power wiring to variable air volume terminal units
b. Starters and disconnects where not furnished integral with equipment.
c. Emergency generator and related equipment.
d. Wiring of smoke detectors.
e. Wiring of Solid State Controller and wiring to associated destratification fans.
f. Wiring of Solid State Controllers to respective exhaust fans.

F. The work of this Section is shown on Drawings numbered, M0.1, M1.1a, M1.1b, M1.1c, M1.2a, M1.2b, M1.2c, M1.3a, M1.3b, M1.1aP, M1.1bP, M1.1cP, M1.2aP, M1.2bP, M1.2cP, M1.3aP, M1.3bP, M1.4, M2.1, M2.2, M2.3, M2.4, M2.5, M2.6, M2.7, M2.8, M2.9, M2.10, and M4.1.

1.4 DEFINITIONS

A. “HVAC” as used hereinafter in this SECTION shall mean “Heating, Ventilating and Air Conditioning.”

B. “HVAC Subcontractor” as used hereinafter in this SECTION shall mean the “Heating, Ventilating and Air Conditioning Subcontractor,” i.e., the filed bid subcontractor under this Section 23 00 00.

C. “Concealed” shall be defined as areas where piping is located in chases, shafts, pipe tunnels, and above furred ceilings.

D. “Underground” shall mean piping exterior to or within the building that is buried. All other piping shall be considered “exposed.”

E. “Piping” shall mean, in addition to pipe, all fittings, valves, hangers, and other accessories relating to such piping systems.

F. “Provide” shall mean “provided complete in place,” that is, “furnished and installed.”

1.5 VALVE TAGS, NAMEPLATES AND CHARTS

A. Furnish and install on each gate and globe valve, and on all automatic control valves used in this contract, a two-inch diameter brass tag with stamped numeral a minimum height of one-half inch painted white. The tags shall be attached to the valve handles or stem necks with brass hooks or chains and properly secured.

B. These numbers shall correspond to numbers indicated for valves on the Record Drawings and on two printed detailed lists. These printed lists shall state the numbers and locations of each valve and control and the section, fixture or equipment which it controls, and other necessary information such as requiring the opening or closing of another valve or valves, when any one valve is to be opened or closed.

C. These printed lists shall be prepared in form to meet approval of the Architect and shall be framed under glass.

D. Nameplates, catalog numbers and rating identification shall be securely attached to electrical and mechanical equipment with screws or rivets. Adhesives or cements will not be permitted.

1.6 SHOP DRAWINGS

A. General: Refer to Division 1, General Requirements, Section 01 33 00, Submittal Procedures, for submittal provisions and procedures.

B. In accordance with Division 1, General Requirements, submit to the Architect for approval complete sets of detailed information consisting of manufacturers' bulletins, capacities, shop drawings, and parts lists of all material to be provided for this project.

C. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. Unless noted otherwise, this is NOT a proprietary specification and it should be noted that "Or approved equal" applies to all products denoted herein. It is understood that all manufactures will have minor variations in configuration, appearance, and product specifications and such minor variations shall not eliminate such manufacturers as an "approved equal". It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that are able to supply similar products.

1.7 CODES, REGULATIONS AND PERMITS

A. All work done under this SECTION shall conform to the codes and regulations governing such work as set forth by the Massachusetts Department of Public Safety, the Massachusetts State Building Code and all local codes having jurisdiction.

B. Give notices, file plans, obtain permits and licenses, and obtain necessary approvals from authorities having jurisdiction. Deliver certificates of inspection to Architect. No work shall be covered before examination and approval by Architect, inspectors and authorities having jurisdiction. Imperfect or condemned work shall be replaced with work conforming to requirements, without extra cost to Owner, subject to the approval of the Architect. If work is covered before due inspection and approval, the HVAC Subcontractor shall pay costs of uncovering the installed work, whether it meets contract requirements or not.

C. Refer to Division 1, Section 01 41 00, Regulatory Requirements.

1.8 INTENT

A. It is not intended that the Drawings show every pipe, fitting, and appurtenance. All such parts necessary for the complete execution of the work, in accordance with the best practices of the trade and to the satisfaction of the Architect shall be provided whether these parts may have been specifically mentioned or not, or indicated on the Drawings.

1.9 DRAWINGS AND SPECIFICATIONS

A. The Drawings and Specifications are complementary each to the other, and any labor or material called for by either, whether or not by both, or necessary for the successful operation of any components shall be furnished and installed.

B. Before installing any work, verify that it does not interfere with the clearances required for other work. Installed work which interferes with existing necessary services shall be modified as directed by the Architect, at no additional cost to the Owner.

C. Be familiar with the Drawings and Specifications of all other trades to prevent interferences and assure complete coordination.

1.10 GIVING INFORMATION

A. Keep fully informed as to the shape, size and position of all openings and foundations required for all apparatus furnished under this SECTION and give full information to the General Contractor sufficiently in advance of the work, so that all such openings and foundations may be built in advance. Furnish all sleeves and supports herein specified, so the General Contractor may build same in place.

B. In the case of failure to give proper information as noted above, assume the cost of having necessary changes to the work made by the General Contractor.

1.11 OBTAINING INFORMATION

A. Obtain detailed information from the manufacturers of apparatus which is to be provided, for the proper methods of installation. Obtain all information from the General Contractor and other Subcontractors which may be necessary to facilitate the work and the completion of the whole project.

1.12 MATERIALS AND EQUIPMENT

A. All materials and equipment furnished under this SECTION shall be new and of the best grade for the service intended. The manufacturers mentioned in the specifications are intended to indicate the quality desired. Any substitutions shall be as approved by the Architect as herein provided by the “or equal” clause, in addition to meeting the limitations of space and capacity shown or specified. Re-built materials and equipment will not be accepted.

1.13 REFERENCES

A. National standards referenced herein are included to establish recognized quality only. Equivalent quality and testing standards will be acceptable subject to their timely submission, review and acceptance by the Designer.

B. Refer to SECTION 01420 - REFERENCES for schedule of references.

C. Reference Standards:

1. Reference herein to any technical society, organizations, group or body are made in accordance with the following abbreviations:

ADC	Air Diffusion Council
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
ARI	Air Conditioning & Refrigeration Institute
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing Materials
AWG	American Wire Gauge
AWS	American Welding Society
FS	Federal Specifications
IEEE	Institute of Electrical and Electronic Engineers
NEC	National Electrical Code
NEMA	National Electrical Manufacturer Association
NFPA	National Fire Protection Association
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
UL	Underwriters Laboratories, Inc.

1.14 COORDINATION DRAWINGS

A. Before materials are purchased or work is begun, the HVAC Subcontractor shall prepare and submit to the Designer, Coordination Drawings showing the size and location of his equipment, ductwork and piping lines relevant to the complete system. He shall ensure that these drawings are compatible and correctly annotated and cross- referenced at their interfaces.

B. Coordination drawings are for the Contractor's and the Designer's use during construction and shall not be construed as replacing any shop or record drawings required elsewhere in these Contract Documents.

1.15 MOTORS AND STARTERS

A. Motors for all equipment under this SECTION shall be quiet in operation and shall be guaranteed to run without objectionable noise or vibration.

B. Motors smaller than one-half (1/2) horsepower shall be wound for 120 volts, single phase, 60 hertz.

C. Motors one-half (1/2) horsepower and larger shall be wound for 480 volt, 3 phase, 60 hertz.

D. Starters for all equipment shall be provided by the Electrical Subcontractor.

E. Voltages shown in Paragraphs B and C are typical unless otherwise noted.

F. All motors one horsepower and over shall be premium efficiency type.

1.16 TEMPORARY HEATING

A. Special reference is made to “Heating during Construction”, Section 01 50 00 - TEMPORARY FACILITIES AND CONTROLS.

1.17 OPERATIONS AND MAINTENANCE MANUALS

A. Refer to SECTION 01 78 00 - CLOSEOUT SUBMITTALS, for submittal procedures pertaining to operating and maintenance manuals.

B. At least two (2) months prior to the time of turning over this contract to the Owner for Use & Occupancy or substantial completion, secure and deliver to the Architect three (3) complete indexed files containing approved operating and maintenance manuals, shop drawings, and other data as follows:
   1. Operating manuals and operating instructions for the various systems.
   2. Catalog data sheets for each item of mechanical or electrical equipment actually installed including performance curves, rating data and parts lists.
   3. Catalog sheets, maintenance manuals, and approved shop drawings of all mechanical or electrical equipment controls and fixtures with all details clearly indicated.
   4. Names, addresses and telephone numbers of repair and service companies for each of the major systems installed under this Contract.
   5. Copies of all service contracts provided for the guarantee period.
   6. Copies of all equipment and system warranties.

C. Non-availability of operating and maintenance manuals or inaccuracies therein may be grounds for cancellation and postponement of any scheduled final inspection by the Owner until such time as the discrepancy has been corrected and/or retainage of sufficient monies to prepare same.

D. Provide qualified trained personnel to insure proper operation of the systems and to train the Owner’s operating and maintenance personnel in the proper operation and maintenance of the systems. Instruction period shall be a minimum of five (5) eight-hour days. Coordinate with Commissioning Agent per specification section 01 91 10.

E. Refer to SECTION 01 75 00, Starting and Adjusting. Coordinate all start-up, operation, and testing activities with the Project Manager, General Contractor and the Commissioning Agent per specification section 01 91 10.

1.18 RECORD DRAWINGS

A. General: Refer to Division 1, General Requirements, SECTION 017800, Close-out Submittals for Requirements.

B. The record drawings required to be furnished under this SECTION are of drawings numbered M0.1, M1.1a, M1.1b, M1.1c, M1.2a, M1.2b, M1.2c, M1.3a, M1.3b, M1.1aP, M1.1bP, M1.1cP, M1.2aP, M1.2bP, M1.2cP, M1.3aP, M1.3bP, M1.4, M2.1, M2.2, M2.3, M2.4, M2.5, M2.6, M2.7, M2.8, M2.9, M2.10, and M4.1.

1.19 CONTRACT COST BREAKDOWN

A. Within 30 days of commencing the work, submit to the Architect a complete breakdown of the Contract price to aid in determining the value of the installed work during the construction period. The form shall correspond to the construction schedule with a percentage of progress to complete breakdown with progress description by month.

1.20 GUARANTEE AND SERVICE

A. Attention is directed to the provisions of the CONTRACT AND GENERAL CONDITIONS regarding guarantees/warranties for the Work.

B. Manufacturers shall provide their standard guarantees/warranties for work under this Section. However, such guarantees/warranties shall be in addition to and not in lieu of all other liabilities which the manufacturer and the Contractor may have by law or by other provisions of the Contract Documents.

1.21 DEBRIS REMOVAL AND CLEAN-UP

A. The HVAC Subcontractor shall, at the end of each day's work, remove waste materials and debris resulting from the installation of the heating, ventilating and air conditioning system. The HVAC Subcontractor shall deposit such waste and debris in a dumpster on-site. Dumpster shall be provided by the General Contractor. The General Contractor shall be responsible for the emptying of dumpster when required.

The HVAC Subcontractor shall, at the completion of his work, remove from the school property all tools, equipment and surplus materials resulting from the installation of the heating, ventilating and air conditioning system.

1.22 COMMISSIONING REQUIREMENTS

A. An independent Commissioning Agent (CA) will be retained for this project. The commissioning process will be implemented in accordance with the LEED for Schools v2009 and Commissioning Credits EAp1 – Fundamental Commissioning of Building Energy Systems and EAc3 – Enhanced Commissioning.

B. This contractor shall assist and support the CA as necessary in accordance with the requirements of specification section 01 91 10 – COMMISSIONING.

1. "Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Tenant's and Building Owner's operation and maintenance personnel, is required in cooperation with Tenant's and Building Owner's Representatives and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation and issue closure. Refer to Commissioning Specification, Section 01 91 10, for detailed commissioning requirements."

1.23 EXAMINATION OF SITE AND DOCUMENTS

A. Bidders are expected to examine and to be thoroughly familiar with all contract documents and with the conditions under which work will be carried out. The Awarding Authority (Owner) will not be responsible for errors, omissions and/or charges for extra work arising from General Contractor or Filed Subcontractor's failure to familiarize themselves with the Contract Documents or existing conditions. By submitting a bid, the Bidder agrees and warrants that he has had the opportunity to examine the site and the Contract Documents, that he is familiar with the conditions and requirements of both and where they require, in any part of the work a given result to be produced, that the Contract Documents are adequate and that he will produce the required results.

B. Pre-Bid Conference: Bidders are strongly encouraged to attend the Pre-Bid conference; refer to INVITATION TO BID for time and date.

1.24 SEQUENCING

A. Phasing: Refer to Section 01 10 00 - SUMMARY, and Drawings for phasing and milestone completion requirements which affect the General Contractor's Work and the Work of this Filed Subcontract.

B. Coordinate work of this Filed Subcontract with that of other trades, affecting or affected by this work, and cooperate with the other trades as is necessary to assure the steady progress of work.

C. Do not order or deliver any materials until all submittals, required in the listed Specification Sections included as part of this Filed Subcontract, have been received and approved by the Architect.

D. Before proceeding with installation work, inspect all project conditions and all work of other trades to assure that all such conditions and work are suitable to satisfactorily receive the work of this Section and notify the Architect in writing of any which are not. Do not proceed further until corrective work has been completed or waived.

PART 2 PRODUCTS

2.1 ACCESS PANELS

A. All work shall be installed so that all parts requiring inspection, operation, maintenance and repair are readily accessible. Minor deviations from the drawings may be made to accomplish this, but changes of magnitude shall not be made prior to written approval from the Architect.

B. Furnish access panels for installation in walls and ceilings at locations indicated on the drawings to permit access.

C. All access panels shall be located in closets, storage rooms and/or other non-public areas, in a workmanlike manner, positioned so that junction can be easily reached and the size shall be sufficient for this purpose (minimum 12 inches x 16 inches). When the access panels are required in corridor, lobbies or other habitable areas, they shall be located as directed by the Architect.

D. Access panels shall be as manufactured by Inland Steel Products Company “Milcor”, Walsh-Hannon-Gladwin, Inc., “Way-Loctor” or approved equal. Types shall be as follows:

1.	Masonry or Tile	“Milcor” Type M
2.	Drywall	“Milcor” Type DW
3.	Fire-Rate	“Milcor”

E. Units shall have 16 gauge steel frame and 14 gauge steel hinged door panel. Door shall have concealed spring hinges allowing door to be opened to 175 degrees.

F. Provide flush screwdriver operated camlocks in accordance with manufacturer’s schedule of panel sizes and number of locks.

G. Units shall be factory primed for field painting by Section 09 00 09.

H. Install U.L. rated 1-1/2 hour Class B access panels where required to comply with applicable code requirements.

2.2 AIR HANDLING UNITS

A. Furnish and install Horizontal Belt Drive Air Handling Units where indicated on the plans and specifications. Units shall be completely factory assembled, tested and shipped as one piece except where noted. Units shall be manufactured by Greenheck, Carrier, Trane, York, McQuay or Nailor.

B. All units shall be capable of meeting or exceeding the scheduled capacities for cooling, heating, and air delivery. All unit dimensions for each model and size shall be considered maximums.

C. All units shall be of "draw-through" design with coils, fans, motor/drive and drain pan completely contained within the unit cabinet.

D. Units shall be ETL listed in compliance with UL/ANSI Standard 1995.

E. All coils shall be certified and tagged with an ARI 410 Label.

F. All units shall be fabricated of minimum 18-gauge galvanized steel with a G60 zinc coating, able to withstand a 125-hour salt spray test per ASTM B-117. Panels shall be die-formed "multi-bend" construction or optimum strength and rigidity. All exterior panels shall be double wall, insulated with 1" thick, 4 pound per cubic foot skin, dual density fiberglass insulation. In addition to using adhesive complying with NFPA 90A, the insulation shall incorporate a secondary mechanical fastener attached to the unit casing wall. Adhesive as the only method of fastening the insulation to the casing is not acceptable. Minimum thermal conductivity shall be 0.24. Insulation must meet all requirements of UL 181 and NFPA 90A. All units shall have minimum 1" duct collars on discharge and return. Double wall liner shall be minimum 22-gauge G60 galvanized steel.

G. All access panels shall be fully insulated and attached with hinged with lift and turn fasteners on at least two (2) opposite sides. No single access panel shall be larger than 30" x 36" for safety and east of handling. No coil or drain piping or electrical connections shall pass through any access panel.

H. Each unit shall be furnished with a one-piece heavy gauge IAQ 304 stainless drain pan with welded corner construction.

I. Double wall units require a trapeze for hanging. Spring type unit mounting vibration isolators shall be provided by the unit manufacturer.

J. All units shall be furnished with standard selection, double width, double inlet, forward curved or airfoil, centrifugal blowers statically and dynamically balanced for smooth operation. All blower wheels shall have two (2) set screws and shall be mounted on solid steel shafting rotating in ball bearings with a minimum design average life of 100,000 hours. All standard blower assemblies shall have resilient mounted cartridge type permanently lubricated ball bearings. All heavy duty blower assemblies shall have relubable type rigid mounted pillow block ball bearings.

K. All fan motors shall be standard NEMA design motors of the horsepower listed in the equipment schedule. All motors shall be 1750 FPM, 60 Hertz (ODP), single speed motors rated for continuous duty. All motors shall be reversible rotation type.

1. Three phase motors shall be "across-the-line" start type in 56 frame size up through two (2) horsepower. Three (3) horsepower and larger shall be standard "T" frame with rigid mount and are EPACT compliant.
2. All motors shall be mounted on an adjustable base.
3. All fan drive assemblies shall include an adjustable pitch motor pulley, a fixed pitch blower pulley and a standard cross section "V-belt". All fan drives shall be selected at a minimum service factor of 1.2.

L. All coils shall be certified and tagged with an ARI 410 Label.

1. All coils shall be 1/2" O.D. seamless copper tubes with collared and corrugated aluminum fins. All tubes shall be mechanically expanded to provide an efficient bond between tube and fin. All water coils shall be provided with a manual air vent fitting to allow for coil venting. Valve core type vent fittings shall not be acceptable.
2. All heating and cooling coils shall have minimum rows required to meet the specified capacity.
3. All coils shall be hydrostatically tested with air under water at 350 psig minimum pressure.

M. All units shall be furnished with a flat filter rack with hinged access on both sides designed to accept 4" nominal standard sized MERV 13 filters. All units shall be provided with nominal throwaway filters, factory installed. One complete set of spare (throwaway) filters shall be provided for each unit.

N. The unit manufacturer shall include a factory assembled inlet damper section. The inlet damper section shall be included within the unit cabinet.

1. The inlet damper section shall include heavy gauge formed steel blade dampers in a heavy gauge steel frame with extruded vinyl blade seals and flexible metal jamb seals. All damper actuators and drive linkage shall be furnished and installed in the field by ATC Contractor.

O. The unit fan motor shall be completely factory wired to an external electrical enclosure. Each unit shall include fan motor operating control with 24-volt control voltage. Each unit shall include motor circuit fusing, control circuit transformer with primary fusing and terminal strip for connection of field wiring.

1. A main incoming power fused disconnect switch shall be factory furnished and wired by the unit manufacturer for single point power connection.

P. All coils shall be 1/2" O.D. seamless copper tubes with collared and corrugated aluminum fins. All tubes shall be mechanically expanded to provide an efficient bond between tube and fin. All water coils shall be provided with a manual air vent fitting to allow for coil venting. Valve core type vent fittings shall not be accepted.

Q. All chilled water, hot water, and direct expansion (DX) coils shall have 0.0055" thick aluminum fins and 0.016" tube wall thickness.

R. All coils shall be hydrostatically tested with air under water at 450 PSIG minimum pressure and rated for a maximum of 300 PSIG working pressure at 200°F.

S. Provide a fully insulated integral filter/mixing box section, when required, complete with return and outside air dampers. Mixing box sections shipped loose for field installation to the units are not acceptable. Filters shall be two-inch (2”) MERV 13.

T. Units shall be furnished with a single point power location and electrical junction box for motor and other electrical terminations.

U. All controls shall be by automatic temperature control contractor.

2.3 AIR SEPARATORS

A. Furnish and install as shown on the drawings a Spirotherm, Bell & Gossett, or Taco air separation fitting on the hot water heating system, chilled water system and condenser water system.

B. All fittings shall be fabricated steel, rated for 150 psig design pressure and be selected for less than 1 foot of water pressure drop and velocity not to exceed 4 feet per second through the unit at specified GPM. Performance curves specifying air collection efficiency and pressure drop at rated flow shall be furnished by the unit manufacturer as part of the submittal for each unit.

C. All units shall include an integral spirally wound three dimensional copper grid to act as a turbulence suppressive coalescing medium which must completely fill the fitting’s internal area. Units are to remove free and entrained air during system start up and continue to eliminate dissolved air through continual circulation and the coalescing action of the spirally wound grid.

1. Alternate units shall have an internal stainless steel air collector tube with 5/32” diameter perforations and 63% open area designed to direct accumulated air to the compression tank via an NPT connection at top of unit.

D. Each fitting is to have a separate air and venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral float actuated brass air vent. There shall be no restriction in the connection from the venting chamber to the vent.

E. The fittings are to include a valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill. Units shall include a bottom connection for use as a blow down connection for periodic cleaning.

F. Provide integral high capacity float actuated air vent at top fitting of tank.
   1. Alternates must include bronze or cast iron float actuated air vent rated at 150 psig which shall be threaded to the top of the fitting.
   2. Unit shall have bottom blow down connection.

2.4 BOILERS

A. Furnish and install in accordance with plans and specifications, including manufacturer's recommendations, state and local code, hot water boilers. The hot water boilers shall be as manufactured by Cleaver-Brooks, Aerco, Buderus, or Viessmann, rated at 60 psig design pressure and capacity, as scheduled on the drawings and specifications.

B. Boiler Design
   1. Boiler shall be a compact Firetube type, single pass, and down-fired design with ultra low emission and high efficiency condensing technology herein listed. The boiler shall be designed for natural gas firing. The burner shall be a forced draft design with gas and combustion air premixed prior to the burner head. The boiler, and burner, shall be supplied by the same manufacturer to assure compatibility and single source responsibility for the package performance. The boilers shall be constructed in accordance with ASME Section IV Code. Boiler to be manufactured within an ISO 9001 certified facility.
   2. The boiler shall be constructed with a minimum of ten (10) square feet of fireside heating surface per 33,475 BTU's of input.
   3. The pressure vessel shall be constructed with stainless steel boiler tubes with titanium stabilized aluminum extended internal heating surface (AluFer). Firetube internal surface shall be a minimum of four (4) times the external waterside surface area. The pressure vessel shall be of a "counter flow" design with separated return flow connections and no minimum system flow requirements.
   4. Other
      a. Two-inch (2") fiberglass blanket insulation and easily removable casing.
      b. Burner observation port.
      c. Factory paint with durable powder coat paint finish for corrosion protection.
      d. ASME Code relief valves with side outlet set for 60 psig.
   5. Hot water boilers shall be specifically designed for top water outlet and bottom water inlet with necessary internal baffling.

C. Computerized Burner Control
1. Boiler burner controls shall be an integrated, digital modulating controller.
2. Controller shall provide the following functions:
   a. Two (2) heating loops
   b. Burner sequencing with safe start check, pre-purge, direct spark ignition and post purge.
   c. Electronic ignition.
   d. Flame supervision.
   e. Safety shutdown with display of error.
   f. Modulating combustion fan.
   g. Circulating pump operation.
   h. Low gas pressure, air proving, high limit and frost protection.
3. Controller shall have an option for multiple boiler sequencing.
4. Controller shall have an option for communication device to computer interface. Boiler manufacturer shall coordinate with Invensys/ENE for compatibility requirements.

D. Burner Design
1. Burner shall be a unitized Venturi, gas valve, blower and burner head design.
2. Burner shall incorporate a variable speed DC combustion air fan capable of modulating the burner at a 5:1 ratio from high fire to low fire.
3. Burner head shall be constructed of a Fecralloy-metal fiber for solid body radiation of the burner flame.
4. Burner shall produce less than 70-dBA sound reading at full firing rate.

E. Electrical Requirements
1. Power available with be 220-1-60 phase with option for 115-1-60.
2. All wiring shall be in compliance with National Electrical Code.

F. Efficiency
1. The boilers will have a guaranteed efficiency of up to 98% based on return water temperatures of 80ºF at full firing rate.

G. Emissions
1. Burner boiler design shall produce NOx emission levels of less than 10 PPM at full firing rate.

H. Operating Tests, Startup and On Site Services:
1. A single vendor to assure proper installation and service design interface, and to provide in-warranty and post-warranty unified responsibility for the Owner and Consulting Engineer, as well as shall furnish the boiler system and accessories.
2. Boiler vendor's service organization shall employ service technicians having experience in all aspects of troubleshooting, corrective service, and preventative maintenance O&M reporting. Service personnel shall be full-time employees of the Vendor's organization and shall be available twenty-four (24) hours per day and three hundred, sixty-five (365) days per year.
3. Boiler vendor shall be covered by a general liability insurance policy. Boiler vendor shall provide the Owner with a Certificate of Insurance specifying amounts and types of coverage. All personnel involved in start-up service, adjustment, or testing of equipment must be covered under this insurance.

4. Boiler vendor shall provide a factory trained service engineer for periodic supervision during installation, field start-up service to supervise starting, adjusting and testing of boiler, training of the operating personnel in the proper operations and maintenance. Duration of training shall be of sufficient time to insure competent operation of boilers by owner's maintenance personnel. Boiler start-up and training shall be coordinated with the Commissioning Agent, refer to specification section 01 91 13.
5. Boiler manufacturer's start-up technician shall provide detailed start-up reports summarizing the start-up procedures and results.

I. Manufacturer's Warranty
1. All equipment shall be guaranteed against defects in materials and/or workmanship for a period of twelve (12) months from the date of startup, or eighteen (18) months from the date of shipment, whichever comes first. The warranty shall include parts only to repair or replace all defective parts and materials.
2. The pressure vessel shall be warranted for twenty (20) years against thermal shock.

J. Condensate Neutralization Kit
1. Boiler manufacturer shall provide a neutralization kit which shall consist of the following:
   a. Replaceable acid neutralization filter cartridge designed for six (6) months of use. The filter housing outlet shall be piped to drain.
   b. Condensate removal pump. The condensate pump shall be capable of handling 70 GPM at 5 ft/hd. The pump discharge shall be piped to filter inlet.

K. Boiler Sequencing and Control System
1. When multiple condensing boilers are to be installed in a common hydronic loop, a sequencing control system shall be provided by the boiler manufacturer to stage and control firing rate of the boilers. To ensure proper integration with the Cleaver-Brooks Clearfire boiler controls, the boiler manufacturer shall supply a boiler sequencing control system. The boilers shall be sequenced as follows to maximize their operating efficiency:

   a. The sequencing control system shall monitor the outdoor temperature and calculate a water loop temperature set point based on the selectable preset values. The sequencing system shall begin sequencing the condensing boilers based on the difference between the actual water loop temperature and the calculated (outdoor air) water temperature.

   b. When a requirement for heat is determined by the boiler sequencing control system, the lead boiler is energized and its firing rate is maintained at low fire.

   c. If the water loop temperature continues to decrease, the boiler sequencing control system shall enable a lag boiler. The first lag boiler is energized and the lag boiler's firing rate is maintained at low fire.

d. If additional heat is required, the boiler sequencing control system shall enable each additional lag boiler stage until all of the available condensing boilers in the water loop have been energized. Each boiler stage shall remain at low fire until all of the stages have been enabled.

e. If all of the condensing boilers are enabled and additional heat is required, the boiler sequencing control system shall release the boilers to modulate. The condensing boilers shall modulate together as a single unit to keep the condensing boiler system at the lowest possible firing rate.

f. As the water loop temperature increases, the boiler sequencing control system shall decrease the firing rate of the condensing boilers to maintain the water loop temperature. If all of the condensing boilers are at low fire and the water loop temperature continues to rise, the boiler sequencing control panel shall begin to stage the boilers off. The first lag boiler energized shall be the first boiler to be disabled. The condensing boilers shall continue to be disabled by the boiler sequencing control system based on the temperature rise of the water loop.

g. The lead boiler is disabled when the water loop temperature reaches a selectable value referenced around the water loop set point.

2. The boiler sequencing control system shall be a microprocessor based Programmable Logic Controller with a Graphical User Interface and Touch Screen capabilities. Active display area will be a minimum of 4.7” with a display resolution of 320 x 240 pixels. Multiple Status and Configuration Screens will be available for easy interpretation of the hydronic loop status and configuration. The boiler sequencing control system enclosure will be NEMA 4X construction. Power required for the boiler sequencing control system will be 120/60/1.

3. The boiler sequencing control system shall have the ability to communicate with the Building Management System via BACnet MS/TP RS-485 or BACnet IP via ethernet. The boiler control system manufacturer shall furnish an interface gateway if required.

4. The boiler sequencing control system Sequencing Control shall include automatic rotation of the lead boiler based on a user configured cycle count. Manual selection of the Lead boiler will also be available through a Setup Menu.

5. Outdoor and loop header temperature sensors supplied with the boiler sequencing control system shall be PT100 RTD type.

6. The boiler sequencing control system sequencing control shall provide an adjustable reset schedule based on the outdoor temperature. A linear outdoor reset ratio shall be determined based on user defined hydronic loop temperatures at 60ºF and 0ºF outdoor temperatures. A reference graphic

shall be displayed on the Boiler sequencing control system representing the reset loop temperature vs. outdoor temperature calculated ratio. A user defined outdoor temp disable parameter shall be provided to turn off all boilers if a predetermined outdoor temperature is reached. Minimum and Maximum Loop Temperature parameters shall be provided for both Occupied and Unoccupied modes. This shall prevent the outdoor reset schedule from operating outside of a user defined temperature range.

7. Provisions shall be provided that monitor the boiler's outlet temperature and adjusts the firing rate if the boiler's outlet temperature exceeds a user defined value above the loop set point. This is beneficial for variable flow loops to prevent high temperature limit alarms.

8. Multiple setback schedules shall be available based on whether the building is in Occupied or Unoccupied mode. Building Mode selection shall be determined by a user defined Time of Day / Day of Week Touchscreen entry. The Building Mode shall automatically change between Occupied and Unoccupied based on the user programmed day and times. Manual Building Mode control shall also be available via a Setup menu. Building Mode shall be indicated on the Loop Status Screen for ease of reference.

9. The boiler sequencing control system Sequencing Control shall provide alarm annunciation of each boiler connected to the network. The boiler sequencing control system shall automatically adjust the boiler sequencing schedule and remove the boiler from the sequencing logic if an alarm occurs. The boiler shall automatically be added back into the rotation loop as soon as the boiler sequencing control system senses that the alarm has been cleared.

10. The boiler sequencing control system will stage the boilers based on a PID generated value. The Proportional, Integral and Derivative values shall be user defined through the Lead/Lag Configuration Screen. Each boiler stage shall be enabled based on a user defined "Percentage from Set point" control variable. Properly tuned loops shall provide temperature control accuracy up to +/- 2ºF. Boiler Sequencing Start and Stop parameters shall be user defined through the operator interface. A Manual Reset parameter shall be provided to allow the Proportional Band to be shifted around set point.

11. The boiler sequencing control system shall provide capabilities to Enable/Disable the boilers through the operator interface. Boilers that are disabled shall not be included in the sequencing logic.

12. A user defined time delay parameter shall be provided that delays enabling of the next boiler stage. This shall help to decrease cycling of the boilers when the heat load is close to being met.

13. The boiler sequencing control system shall modulate the individual boiler's automatic two-way control valve isolate any boiler not online. The boiler sequencing control system shall provide a user defined time delay to keep the isolation valve open to relieve heat from the boiler after being staged off.

2.5 BREECHING AND CHIMNEY (DOUBLE WALL AL29-4C)

A. Furnish and install, where indicated on plans, non-positive and positive pressure vent systems for condensing and non-condensing applications.

B. Standards:

1. Where applicable, products furnished under this section shall conform to the requirements of NFPA 54 and NFPA 211, and shall comply with UL 1738, Standard for Venting Systems for Category II, III, and IV Gas-Burning Appliances, and all other applicable standards.
2. All flue-gas carrying components of the vent system shall be obtained through one source.
3. Vent shall be warranted by the manufacturer against defects in material and workmanship for a period of one (1) year from the date of original installation. Any portion of the vent repaired or replaced under warranty shall be warranted for the remainder of the original warranty period.

C. Special Gas Vent:

1. Vent shall be factory-built special gas type, double wall, engineered and designed for use on Category I, II, III, and IV appliances, or as specified by the equipment manufacturer.
2. Maximum continuous flue gas temperature not to exceed 550 degrees Fahrenheit (288 degrees Celsius).
3. Vent shall be constructed with an inner conduit constructed of AL29-4C® or 29-4 (S44735) superferritic stainless steel with a minimum thickness of .015” for diameters 3”-8”, .020” for diameters 10”-16”, .025” for diameters 18”-24”, and .035” for 26” and greater.
4. Vent shall be listed for an internal static pressure of 15” w.g. and tested to 37” w.g.
5. All inner wall conduit components shall be manufactured from AL29-4C® or 29-4 (S44735). The closure system shall be a mechanical locking strap closure system that is integral to the system.
6. Joints to be sealed with factory supplied sealant. Joints shall be designed to minimize collection of condensate in both horizontal and vertical runs. Joints shall not use screws or other lesser alloy fasteners that penetrate the inner conduit.
7. The outer wall casing shall be constructed of 430 stainless steel that shall not require additional surface preparation, such as painting, in order to withstand the outdoors or high humidity environments.
8. Inner conduit and outer wall casing shall be constructed with a one-inch air space between them and in such a fashion that prevents cross-alloy contamination.
9. Tees and elbows shall provide a pressure drop less than 15 feet equivalent horizontal vent.
10. Fittings that increase or decrease vent diameter shall be asymmetric in construction with a flat wall that maintains a straight line with adjoining parts in order to facilitate the unobstructed flow of all condensate.
11. All parts shall be compatible with other single wall and double wall products of the same manufacturer.

12. System is to be sized in accordance with the appliance manufacturer's specifications, NFPA 54-National Fuel Gas Code (ANSI Z223.1), ASHRAE recommendations, and other applicable codes.
13. System shall be design with parts that will allow for clearance to combustibles of 1" for diameters 6"-24" unenclosed in the horizontal and enclosed in the vertical; and for clearance to combustible of 2" for diameters 26"-32" unenclosed in the horizontal and enclosed in the vertical.
14. Manufacturer shall provide, if needed, any custom made part to aid in a quick and effective installation. Custom parts will meet all criteria 3.1.A through 3.1.N.

D. Sealant:

1. General Electric RTV106 High Temperature Sealant shall be used to seal all joints on systems where the maximum flue gas temperature will not exceed 550°F.
2. In lieu of high temperature sealant, a factory installed 550°F compatible gasket shall be used to seal the joints.

E. Illustrated installation manuals shall be supplied to the installer and shall be available for downloading from the manufacturer's website.

F. All components shall be installed in strict compliance with the manufacturer's instructions and all pertinent local, regional, national, and international building and mechanical codes and regulations.

G. Vent shall be Saf-T Vent® CI Plus as manufactured by Heat-fab, Inc. or approved equal."

2.6 CABINET UNIT HEATERS

A. Cabinet unit heaters shall be of the size, type and capacity indicated on drawings. Equipment shall be as manufactured by Vulcan, Sterling, Rosemex or Rittling.

B. Cabinet unit heaters shall consist of a heating element with centrifugal fans driven by an electrical motor, filter, and where semi or fully recessed, they shall be flanged on four sides. They shall be capable of delivering the indicated heat emission with entering air at 60 degrees F. Each unit shall be provided with manual on-off switch and two-speed selector switch.

C. All cabinet parts shall be factory finished. Color to be determined by Architect.

2.7 CEILING MOUNTED INDUCTION UNITS (ACTIVE CHILLED BEAMS)

A. Units shall be as manufactured by NuClimate Air Quality Systems, Titus or Flakt/Woods.

B. The following substitution considerations shall apply to any manufacturer requesting prior approval:

1 The following submittal documentation for every product proposed shall include the following:

a. Schedule and performance data for each with physical and thermal calculations.

b. Include an independent testing report for performance, sound and throws.

2. Alternate manufacturer must provide equipment with similar air distribution characteristics.
3. Any and all costs associated with using a substituted product shall be the responsibility of the Mechanical Contractor. This includes but is not limited to redesign fees, additional piping and ductwork and controls required.

C. It is the design intent of these specifications to provide a fully integrated HVAC system with all parts working together. These induction units need clean, dehumidified primary air from a dedicated outdoor air unit, hot and chilled water from a boiler and chiller, piping, and controls to coordinate each component to perform as intended. In addition to the items mentioned above that are specified on other sections in Division 23, wiring and power requirements in Division 26 may also be impacted. Changes, modifications, or substitutions on any component will impact all the other parts of the system and can not be made without a careful review of all related specifications.

D. All cabinet parts shall be factory finished. Color to be determined by Architect. Induction terminal unit shall be constant volume primary air flow units designed to induce a secondary airflow within the conditioned space using the primary conditioned air supply. Units shall be designed for ceiling installation with factory supplied hanging brackets. Hanger rods or cable hanging system to be field supplied and installed in the field by installing contractor.

E. Each induction unit shall be equipped with a round duct primary air intake, one air plenum and air induction nozzle plate, one chilled/hot water coil, a supply and a return chilled water piping connection, a supply and a return hot water piping connection, one ¾" condensate drain connection, and one combination supply / return air grille to create a coanda effect room air distribution. The grille shall have a removable center core to provide full access to the return air side of the coil. The unit shall be capable of inducing the secondary airflow within the conditioned space using the velocity pressure of the primary airflow. This secondary air must flow directly from the room to the unit and shall not use the ceiling as a return air plenum. Induction units using the ceiling plenum as a return air path are not acceptable.

F. Each one-way throw unit shall be equipped with a round duct primary air intake, one air plenum and air induction nozzle plate, one chilled water and one hot water coil, a supply and a return chilled water piping connection, a supply and a return hot water piping connection, one ¾" condensate drain connection, and one combination supply / return air grille for a full one way or 360 degree coanda effect room air distribution. The grille shall have a removable center core to provide full access to the return air side of the coil. The unit shall be capable of inducing the secondary airflow within the conditioned space using the velocity pressure of the primary airflow. This secondary air must flow directly from the room to the unit and shall not use the ceiling as a return air plenum. Induction units using the ceiling plenum as a return air path are not acceptable.

G. Each unit shall be equipped with one water coil for chilled water and one water coil for hot water. Latent conditioning of the air supplied to the space shall be performed at the Dedicated Outdoor Air unit and controlled by exhaust air humidity sensors. Humidity within the building envelope is to be controlled to not exceed 55% relative humidity.

H. For non drainable applications, a drainable condensate pan with a safety float switch attached to the drain pan shall be provided by the induction unit manufacturer to shut off the chilled water coil if condensate should accumulate.

I. The induction units shall be matched up to a supplied supply/return diffuser to evenly distribute the mixed primary air in a coanda effect air distribution pattern. The diffuser shall fit into a standard ceiling grid.

J. Unit shall be ETL certified. Submittal shall include an independent ETL certified test report certifying noise levels below NC29 at 0.8" primary air inlet pressure.

K. Casings:
1. The entire unit shall be constructed of 20 gauge galvanized sheet metal. The primary air plenum and nozzles shall be designed and configured to provide uniform air distribution with low noise operation to all nozzles. Casings hall have a Soundcoat Polyurethane insulation that meets UL 94 HF-1 standards.

2. The air diffuser shall be removable for access to the interior coil area for cleaning.

L. Induction Nozzles:
1. Induction nozzles shall be aerodynamically designed and made of LDPE Petrothene food grade plastic having a tapered discharge to minimize noise. Nozzles shall be tested and meet UL94 and UL746.

M. Water Coil Assembly:
1. Coils shall be of the hot and chilled water type utilizing aluminum fins and copper tubes. Copper tube wall shall be a minimum .033 thickness. Coils shall be factory leak tested at 350 PSI water. Coil connections shall be as indicated on the drawings.Coils shall carry an ARI 410 stamp.
2. Coil must be one continuous assembly to minimize leakage.
3. The water coil assembly shall consist of a two row copper tube and aluminum fins coil for cooling and one row coil for heating. A drainable condensate pan shall be provided to collect any condensate that might form. Drain pans shall be tested and meet UL94 and UL746 standards.
4. Control valves for cooling and heating can control one or more induction unit in a given zone. Control valves for the units shall be supplied by the Automatic Temperature Control Contractor.
5. Provide water supply / return connection as a pre-assembled automatic balancing hose kit as shown on the drawings. Manufactured by Nu-Tech, Griswold or Flow Design.

N. Quality Assurance:
1. All induction terminal units shall be tested prior to submitting by an independent Nationally Recognized Testing Laboratory for performance, throws, and sound levels.

O. Warranty:
1. Units shall be warranted against failures on parts for a period of 12 months from shipment or 18 months from startup, whichever occurs first.
2. In warranty labor shall be the responsibility of the installing contractor."

2.8 CHEMICAL TREATMENT

A. Provide where shown on drawings and as specified herein the equipment necessary for chemical treatment and service as provided by New England Systems and Supply, Inc., Nutmeg, Metropolitan Refinery Company, Inc., Barclay Chemical Company, Inc., Betz Company or Water Services Laboratories, Inc., or approved equal.

B. The contract agreement satisfactory in form and substance to the Owner – executed between this Contractor and the chemical treatment company to furnish supervisory service to assure the use of proper chemical treatment to and for systems, installed under this contract, hot water, chilled water and condenser water, for a period of one (1) year from date of initial treatment thereof. The Contract: Assigned by this Contractor to the Owner on the date that the building is accepted by the Owner, so that chemical treatment will continue uninterrupted during the one year life of the contract. If the building is not accepted by the Owner prior to the expiration of the one year contract, arrangements shall be made by this Contractor to extend this contract until the building is accepted by the Owner.

C. Chemical treatment company shall perform the following through its agents:
1. Supervise initial cleaning of systems and equipment.
2. Supervise initial introduction of chemical treatment.
3. Furnish service calls by its agents at a frequency of not less than one (1) per thirty (30) days thereafter, during the one (1) year life of the contract.
4. Furnish all required chemicals for proper treatment of all systems hereinafter described, together with all necessary testing equipment and reagents for field analysis of the water during the aforementioned one year contract.
5. The chemical treatment company shall assume responsibility for field testing and control and regular addition of chemical treatment in whatever amounts are necessary on each of the systems hereinafter described, as provided by the chemical treatment company until the date of acceptance of the building by the Owner.
6. Some water circulating pumps shall have mechanical seals as specified in this section. It shall be the responsibility of the chemical treatment company to coordinate with the pump manufacturer and adjust the formulation of the water treatment chemicals to be assured that the normal life of the mechanical seals is not affected.
7. The chemical treatment supplier shall provide chemicals which are non-pollutants and meet Federal Water Quality criteria.
8. The chemical treatment company shall establish, document and submit to the Architect volumes of each system or sub-system for which treatment is provided.
9. The chemical treatment company shall provide start-up and training support to the owner. Training shall be coordinated with the Commissioning Agent. Refer to specification section 01 91 13 for additional requirements.

D. Hot Water Systems: Provide for each system one liquid chemical bypass type feeder of approximately 5 gallon capacity, complete with valves and fittings which shall be connected across each hot water heating system pump set.

E. Chilled Water System: Provide liquid chemical bypass type feeder of approximately 5 gallon capacity, complete with valves and fittings connected across the chilled water pump sets.

F. Chemical cleaning solutions used shall not be harmful to materials of construction. After systems have been drained, flushed and refilled, a chemical test shall be made by the chemical treatment company to determine that cleaning solution remaining in system does not impart alkalinity to water in excess of 300 ppm. A written report to this affect shall be submitted to the Architect.

G. Initial Cleaning of Chilled Water, Hot Water Piping System: Cutting oil, excess pipe joint compound, finely divided solids and other similar foreign materials shall be removed from all circulating water and steam piping systems before they are placed in operation. The cleaning materials used shall be supplied and applied by the chemical treatment company and all circulation, draining, flushing and refilling work shall be done by this Contractor, as directed by the chemical treatment company.

H. Refer to Piping Systems Flushing and Cleaning for additional requirements.

2.9 CHILLER (AIR COOLED)

A. The contractor shall furnish and install air-cooled water chillers as shown as scheduled on the contract documents. The chillers shall be installed in accordance with this specification and perform at the specified conditions as scheduled.

B. The contractor shall furnish and install air-cooled rotary liquid chiller of size and capacity scheduled. Unit shall be installed in strict accordance with this specification. All units shall be furnished complete with helical rotary compressors, shell and tube evaporator, air-cooled condenser, electronic expansion valves and microprocessor control panel. Total unit shall be UL certified and include the UL label. The unit shall be designed for outdoor application. The unit shall be rated in accordance with AHRI Standard 550/590-2003.

C. Air cooled water chiller(s) shall be manufactured by Trane, York, Carrier or Daikin.

D. Compressors
1. Construct chiller using semi-hermetic helical rotary screw compressors with independent circuits.
2. Statically and dynamically balance rotating parts.
3. Provide oil lubrication system with oil charging valve and oil filter to ensure adequate lubrication during starting, stopping, and normal operation.
4. Provide compressor with automatic capacity reduction equipment consisting of capacity control slide valve. Compressor must start unloaded for soft start on motors.
5. Provide constant speed 3600 rpm for 60Hz (or 3000 rpm for 50Hz) compressor motor, suction gas cooled with robust construction and system design protection, designed for across-the-line or wye-delta starting. Furnish with starter.
6. Provide compressor heater to evaporate refrigerant returning to compressor during shut down. Energize heater when compressor is not operating.
7. Provide sound absorbing panels to attenuate compressor noise.

E. Evaporator

1. The evaporator shall be designed, tested, and stamped in accordance with ASME code for a refrigerant side working pressure of 200 psig. Waterside working pressure shall be 150 psig.
2. Insulate the evaporator and water boxes with a minimum of 3/4 inch (K=0.26) insulation. If field installed the additional money to cover this in the field should be included in the bid.
3. Evaporator heat tape shall be factory installed and shall protect unit down to -20 F. Contractor shall wire separate power to energize heat tape and protect cooler while chiller is disconnected from the main power.
4. Provide shell and tube type evaporator, seamless or welded steel construction with cast iron or fabricated steel heads, seamless internally and externally finned copper tubes, roller expanded into tube sheets.
5. Provide ability to remove evaporator tubes from either end of the heat exchanger.
6. Provide water drain connection, vent and fittings for factory installed leaving water temperature control and low temperature cutout sensors.
7. Water connections shall be grooved pipe. Evaporator shall have only one entering and one leaving connection. If manufacturer provides 2 separate evaporators, contractor shall provide manifold and pressure gauges to ensure equal flow is provided to each evaporator.
8. Proof of flow shall be provided by the equipment manufacturer, mechanically installed and electrically wired, at the factory of origin.

F. Condensers and Fans

1. Condenser fans shall be low-sound propeller-type, arranged for vertical air discharge and individually driven by direct-drive fan motors. Fan motors shall be weather protected, three-phase, direct-drive, 850 rpm, totally enclosed air-over motors (TEAO), with class F insulation or better. ODP motors are not acceptable. Each fan shall be housed in its own compartment to eliminate condenser air cross-flow during fan cycling and shall be equipped with a heavy-gauge close-meshed PVC-coated fan guard.
2. Provide TEAO (Totally Enclosed Air Over) fan motors with permanently lubricated ball bearings.
3. Construct condenser coils of aluminum fins mechanically bonded to seamless copper tubing. Provide sub-cooling circuits. Air test under water to 506 psig.
4. Provide coil protection for shipping. Entire condenser coil shall be covered with heavy plastic to prevent inadvertent damage to coil during shipment or rigging.

G. Enclosures/Starters

1. House components in a galvanized steel frame and mounted on welded structural steel base. Hot-dip galvanized steel frame coating shall be Underwriters Laboratories Inc. (UL) recognized as G90-U, UL guide number DTHW2.
2. Unit panels and control panels shall be finished with a baked on powder paint. Control panel doors shall have door stays. Paint system shall meet the requirements for outdoor equipment of Federal Government Agencies.

3. Mount starters and Terminal Blocks in weatherproof panel provided with full opening access doors. Factory mounted and wired disconnect should be a lockable, through-the-door type with an operating handle and clearly visible from outside of unit indicating if power is on or off.
4. Casings fabricated from steel that do not have a Zinc coating conforming to ASTM A 123 or ASTM A525 shall be treated for the prevention of corrosion with a factory coating or paint system. The coating or paint system shall withstand 500 hours in a salt-spray fog test in accordance with ASTM B 117. Each specimen shall have a standard scribe mark as defined in ASTM D 1654. Upon completion of exposure, the coating or paint system shall be evaluated and rated in accordance with procedures A and B of ASTM D 1654. The rating of failure at the scribe mark shall be not less than six (average creepage not greater than 1/8 inch). The rating of the unscribed area shall not be less than ten (no failure). Thickness of coating or paint system on the actual equipment shall be identical to that on the test specimens with respect to materials, conditions of application, and dry-film thickness.
5. For each compressor provide a wye-delta starter. Delta-Delta and Solid State Starters shall be unacceptable because they accomplish a smaller reduction in inrush than Y-delta.

H. Refrigerant Circuit

1. All units shall have 2 refrigeration circuits to provide redundancy, each with one or two (manifolded) compressors on each circuit. Single refrigerant circuit chillers are not acceptable.
2. Provide for each refrigerant circuit:
   a. Liquid line shutoff valve.
   b. Suction Service Valve
   c. Filter (replaceable core type).
   d. Liquid line sight glass.
   e. Electronic or thermal expansion valve sized for maximum operating pressure.
   f. Charging valve.
   g. Discharge and oil line check valves.
   h. High side pressure relief valve.
   i. Full operating charge of HFC-134a and oil for packaged units only. Units with remote evaporator option selected will ship with an oil charge and a nitrogen holding charge.
3. Capacity Modulation: Provide capacity modulation that includes linear unloading to maintain close leaving water temperature control. Unit shall be capable of operation down to 20%.

I. Controls

1. Chilled water temperature control shall be microprocessor-based, proportional and integral controller to show water and refrigerant temperature, refrigerant pressure, and diagnostics. This microprocessor-based controller is to be supplied with each chiller by the chiller manufacturer. Controls shall include the following readouts and diagnostics:
   a. Phase reversal/unbalance/single phasing and over/under voltage protection.

b. Low chilled water temperature protection.
c. High and low refrigerant pressure protection.
d. Load limit thermostat to limit compressor loading on high return water temperature.
e. Condenser fan sequencing to automatically cycle fans in response to load, expansion valve pressure, condenser pressure, and differential pressure to optimize unit efficiency.
f. Display diagnostics.
g. Oil pressure control based off of maintaining system differential pressure.
h. Compressors: Status (on/off), %RLA, anti-short cycle timer, and automatic compressor lead-lag.

2. On chiller, mount weatherproof control panel, containing starters, power and control wiring, factory wired with terminal block power connection. Provide primary and secondary fused control power transformer and a single 115 volt 60 Hz single phase connection for evaporator freeze protection heaters.
   a. The unit controller shall utilize a microprocessor that will automatically take action to prevent unit shut down due to abnormal operating conditions associated with: evaporator refrigerant temperature, high condensing pressure and motor current overload.
3. In the above case, the chiller will continue to run in an unloaded state, and will continue to produce some chilled water in an attempt to meet the cooling load. However, if the chiller reaches the trip-out limits, the chiller controls will take the chiller off line for protection, and a manual reset will be required. Once the "near-trip" condition is corrected, the chiller will return to normal operation and can then produce full load cooling.
4. Provide the following safety controls with indicating lights or diagnostic readouts.
   a. Low chilled water temperature protection.
   b. High refrigerant pressure.
   c. Low oil flow protection.
   d. Loss of chilled water flow.
   e. Contact for remote emergency shutdown.
   f. Motor current overload.
   g. Phase reversal/unbalance/single phasing.
   h. Over/under voltage.
   i. Failure of water temperature sensor used by controller.
   j. Compressor status (on or off).
5. Provide the following operating controls:
   a. Eight (8) or more step leaving chilled water temperature controller which cycles compressors and activates cylinder unloaders or slide valve based on PI algorithms. If manufacturer is unable to provide at least 8 steps of unloading, providing hot gas bypass shall be required.
   b. Five minute solid state anti-recycle timer to prevent compressor from short cycling. Compressor minimum stop-to-start time limit shall be 2 minutes. If a greater than 5 minute start-to-start, or greater than 2 minute stop-to-start timer is included, hot gas bypass shall be provided to insure accurate chilled water temperature control in light load applications.
   c. Chilled water pump output relay that closes when the chiller is given a signal to start.

d. Load limit thermostat to limit compressor loading on high return water temperature to prevent nuisance trip outs.
e. High ambient unloader pressure controller that unloads compressors to keep head pressure under control and help prevent high pressure nuisance trip outs on days when outside ambient is above design.
f. Compressor current sensing unloader unit that unloads compressors to help prevent current overload nuisance trip outs.
g. Auto lead-lag functions that constantly even out run hours and compressor starts automatically. If contractor cannot provide this function then cycle counter and hour meter shall be provided for each compressor so owner can be instructed by the contractor on how to manually change lead-lag on compressors and even out compressor starts and running hours.
h. Low ambient lockout control with adjustable set point.
i. Condenser fan sequencing which automatically cycles fans in response to ambient, condensing pressure and expansion valve pressure differential thereby optimizing unit efficiency.

6. Provide user interface on the front of the panel. If display is on the inside of the panel, then a control display access door shall be provided to allow access to the display without removal of panels. Provide user interface with a minimum of the following features:
   a. Leaving chilled water set point adjustment from LCD input
   b. Entering and leaving chilled water temperature output
   c. Percent RLA output for each compressor
   d. Pressure output of condenser for circuits one and two
   e. Pressure output of evaporator for circuits one and two
   f. Ambient temperature output
   g. Voltage output
   h. Current limit set point adjustment from LCD input.
   i. Remote leaving water temperature set point.
   j. Alarm indicating light and relay.
7. The chiller control system shall be capable of communicating with the building management system via BACnet MS/TP RS-485 or BACnet IP via ethernet. Any and all communication interface cards required shall be furnished by the chiller manufacturer.
8. The chiller control panel shall provide leaving chilled water temperature reset based upon return water temperature.
9. The chiller control panel shall provide an alarm relay output that shall energize whenever a fault requiring manual reset is detected by the panel.
10. The chiller control panel shall provide input for leaving chilled water temperature set point based upon a 2-10VDC or 4-20mA signal from a building automation system.
11. The chiller control panel shall provide input for chiller current limit set point based upon a 2-10VDC or 4-20mA signal from a building automation system.

J. Regulatory Requirements

1. Conform to ANSI/AHRI 550/590-2003 Standard for testing and certified rating of Water Chilling Packages using the Vapor Compression Cycle.

2. Conform to ANSI/UL 1995 code for construction of water chillers. In the event the unit is not UL approved, the manufacturer shall, at manufacturer expense, provide for a field inspection by an UL representative to verify conformance to UL standards. If necessary, contractor shall perform modifications to the unit to comply with UL, as directed by the UL representative.
3. Conform to ANSI/ASME SEC 8 Boiler and Pressure Vessel Code for construction and testing of water chillers.
4. Conform to ANSI/ASHRAE 15 code for construction and operation of water chillers.
5. Chiller must be built in an ISO 9001 classified facility.

K. Verification of Capacity and Efficiency

1. The chiller (one of each size) shall be factory performance tested under full load conditions in an ambient controlled, AHRI 550/590-2003 approved test facility. The manufacturer shall supply a certified test report to confirm performance as specified. The performance test shall be conducted in accordance with AHRI Standard 550/590-2003 procedures and tolerances.
   a. The performance test shall be run with clean tubes in accordance with AHRI 550/590-2003 to include the following:
   a. A downward temperature adjustment shall be made to the design leaving evaporator water temperature to adjust from the design fouling to the clean tube condition.
   b. The factory test instrumentation shall be per AHRI 550/590-2003, and the calibration of all instrumentation shall be traceable to the National Institute of Technology.
   c. The owner or his representative shall be notified 14 days in advance to witness the factory performance test. If the owner or his representative desires to witness the performance test, all travel expenses will be the owner's responsibility.
   d. A certified test report of all data shall be submitted to the Contracting Officer prior to completion of the project. The factory certified test report shall be signed by an officer of the manufacturer's company. Preprinted certification will not be acceptable; certification shall be in the original.

L. Manufacturer's Field Services

1. OEM Startup shall be performed by factory trained and authorized servicing technicians confirming equipment has been correctly installed and passes specification checklist prior to equipment becoming operational and covered under OEM warranty.
2. The manufacturer shall furnish complete submittal wiring diagrams of the package unit as applicable for field maintenance and service.

M. Warranty

1. Provide a full parts warranty for one year from start-up or 18 months from shipment, whichever occurs first.
2. A 5-year motor/transmission/compressor warranty shall be provided.

2.10 CONVECTORS

A. Furnish and install where shown on the drawings, convectors with inlet grilles and access doors of sizes, capacities and type indicated on the schedule. All convectors shall be complete with air vent chamber and key operated air cocks. Heating elements shall consist of seamless copper tubes, non-ferrous fins, cast iron headers and galvanized steel sideplates and tube supports. Each convector shall have installed in return line an approved balancing fitting with adjusting screw. All recessed convector casings on outside walls shall be entirely covered within recess with at least 1/2 inch insulation sheet securely secured to the casing. All exposed screw heads shall be tamperproof, Phillips, Allen or approved equal. All recessed and semi-recessed convector front panels shall be 14 gauge enameled steel and be flanged on four sides. The convectors shall be as manufactured by Vulcan, Sterling, Rosemex or Rittling.

B. Convectors shall be factory finished. Color to be determined by Architect.

2.11 DUCTLESS SPLIT FANCOIL SYSTEM

A. Provide a complete split system type ductless fancoil air conditioning system consisting of compact mounted packaged evaporator sections with matching air cooled outdoor condensing unit. The units shall be listed by the Electrical Testing Laboratories (ETL) and bear the ETL label. All wiring to be in accordance with the National Electrical Code (NEC). The units shall be rated in accordance with ARI Standard 210 and bear the ARI label. A full charge of R-410a refrigerant shall be provided in the condensing unit. System SEER shall meet or exceed 1992 Federal Standards.

1. The system components shall be provided by a single manufacturer to provide for an integrated, 100% compatible installation. System shall be as manufactured by Mitsubishi Company, Sanyo Company or Trane.

B. The units shall have a manufacturer's warranty for a period of one (1) year from date of installation. The compressor shall have a warranty of six (6) years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the site of installation.

C. The indoor unit shall provide a total minimum cooling capacity as scheduled on the drawings. The system efficiency shall be as scheduled on the drawings. The system net minimum total cooling capacity shall be rated at 67 degrees FDB indoor and 95 degrees FDB air entering the outdoor coil.

D. The indoor unit shall be completely factory assembled and wired. The casing shall be of galvanized sheet steel, phosphatized, bonderized and finished in a baked enamel white finish.

1. The evaporator fan shall be a high performance forward curve line flow fan direct driven by a single motor. The fan shall be statically and dynamically balanced and shall run on permanently lubricated bearings.
2. An adjustable change vane shall be provided with the ability to direct the air flow from horizontal to vertical. An adjustable guide vane shall be provided to manually change the air direction from left to right.

3. The evaporator coil shall be of nonferrous construction with smooth plate fins bonded to copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phoscopper or silver alloy. The coils shall be pressure tested to 450 psig at the factory.
4. An insulated condensate pan with drain shall be provided under the coil.

E. The control system shall consist of multiple microprocessor sections. One microprocessor shall be factory wired and located within each indoor unit. It shall have the capability of sensing room temperature and indoor coil temperature; receive and process commands from the remote controller; and control the outdoor unit. The Contractor shall be responsible for required interlock wiring.
1. The microprocessor within the wall mounted remote controller shall display setpoint; provide two (2) manually selected modes of cooling, normal and economy operation at 2 degrees above setpoint; night set back operation of 4 degrees above setpoint; and manual or automatic fan speed control.
2. The optimum temperature shall be memorized for immediate recall as the system default setpoint whenever the system is used again.
3. The system shall be capable of automatic restart when power is restored after power interruption.
4. Automatic fan speed control shall be based upon the temperature difference between setpoint and room temperature maintaining lowest speed possible.

5. A remote control unit shall be wireless, using infrared, line of sight for control of system and shall include automatic ON/OFF timer; liquid crystal display, and temperature reset capability. Furnish and install, in the field, on the wall, a remote control unit holder.

F. The outdoor unit shall be completely factory assembled, piped and wired. The casing shall be fabricated of galvanized steel, phosphatized, bonderized and finished with baked enamel. The unit shall be furnished with direct drive, propeller type fans arranged for horizontal discharge.
1. The motor shall have inherent protection, be of the permanently lubricated type and resiliently mounted for quiet operation.
2. The fans shall be provided with a raised guard to prevent contact with moving parts.
3. Multiple compressors shall be provided, one for each indoor evaporator fancoil unit. The compressors shall be of the high performance rotary type with accumulator and internal thermal overloads. The compressors shall be mounted so as to avoid the transmission of vibration.
4. The refrigeration system shall have the capability to operate with maximum height difference of 25 feet and overall refrigerant tubing length of 160 linear feet between indoor and outdoor sections without the need for line size changes, traps, or additional oil. Refrigerant flow from the condenser to be controlled by means of capillary tubes.
5. The condenser coil shall be non-ferrous construction with smooth plate fins bonded to copper tubing. The coil shall be protected with an internal metal guard finish to match unit panels.
6. The unit shall be controlled by the microprocessor located in the matching indoor units.

2.12 DUST COLLECTOR SYSTEM

A. Housing:
   1. Housing construction is 12 gauge steel, rated for + or -20 in/ wg. and designed in compliance with IBC2003 International Building Codes. The tube sheet is 3/16 in (7 gauge) steel.

B. Finish:
   1. Exterior surfaces are painted with blue finish. Interior surfaces are primed gray.

C. Discharge Hopper:
   1. Hopper is 12 gauge steel with side panel and valley angles exceeding 60 deg. Bottom discharge is a 14.25 in. square opening. Discharge hopper attaches to 55 Gallon Drum provided be others.

D. Support Leg Structure:
   1. Legs provide 48" clearance below the hopper discharge flange and are designed per the IBC code for 90 mph, Exposure C wind load, seismic spectral response accelerations of Sc = 1.5g and S1 = 0.6g, and ground snow loads of 40 psf. Cross bracing is included on three sides.

E. Dust Laden Inlet:
   1. A Directed Flow inlet properly distributes the dust laden air through the dirty air plenum, keeps the underside of the filters clean, prevents filters abrasion, maximizes dust drop-out and eliminates hopper sweeping and dust re-entrainment. Side inlet locations and standard.

F. PowerCore Filter Packs:
   1. Each compact PowerCore Filter Pac incorporates multiple layers of Ultra-Web media packaged in flutes that intercept even the smallest particles. Laboratory testing has determined that PowerCore Filter Pacs produce 60% fewer emissions than standard 16 oz polyester bags.
   2. Each PowerCore Filter Pac contains 63 square feet of effective UltraWeb media.

G. Filter Cleaning:
   1. PowerCore Filter Pacs are automatically cleaned by periodic pulses of compressed air. The patented compact Oblique Pulse Cleaning System matches the pulse shape to the PowerCore Filter Pac providing maximum cleaning effectiveness.

H. Cleaning Controls:
   1. The proprietary solid-state Torit Delta P Control Board, features a digital read-out display, includes a choice of two cleaning modes, continuous or after-shift. The after-shift cleaning mode pulse cleans the filer cartridges in a unique shutdown sequence to eliminate direct worker exposure to pulse noise. It provided filer restriction and cleaning control; starting and stopping the cleaning process at user selected set points. No batter backup required.

I. Prewired Solenoids:

1. Solenoids will be factory wired to a terminal strip in a NEMA-4 enclosure. A single wire per solenoid and a common will be routed through conduit to the enclosure (1), located on the right and left side of the Collector. All conduit and fittings are PVC. Wiring from the Control Panel to the Collector Solenoids requires six (6) low voltage (115v) wires and one (1) common, for pulsing. Provided by electrical Contractor.

J. Pulse Mufflers:
1. Solenoid Mufflers will be installed on the exhaust side of each solenoid valve to reduce the filter cleaning pulse noise.

K. Electric Control Panel:
1. Includes motor starter (1), circuit protection for each motor (1), a transformer, pulse cleaning controls, Torit Delta p Plus control mounted disconnect switch. All components are IEC rated; the enclosure is rated NEMA-12 with a 460 primary voltage. Pneumatic tubes (2) must be run from the collector to the Control Panel to operate pulse cleaning timer board, this will be provided by the HVAC contractor.
2. Air Flow Controller: NEMA 12 Control system to have a minimum 5 kA SCCR. Variable frequency Drive with Airflow Control. Airflow control to actively monitor duct velocity and correct to meet design based on changes in pressure drop. Airflow controller is not to utilize sensors in the dirty air duct work
   a. Panel shall include Control Panel Disconnect and Blower running pilot light,
   b. Delta P Plus controller shall indicate pressure drop and control pulse cleaning while blower runs and during off time.
   c. Solenoid Heater valve control with oversized transformer to accommodate heat load.

L. Filter Access:
1. PowerCore Filter Pacs are easily accessed from the exterior clean side of the collector via an access door on top of the collector. Filter removal and replacement can be accomplished from outside the collector without the need for tools.
2. Stationary Platform including welded platform, railing system with safety bar knee bracing and ladder, painted safety yellow.

M. Torit Direct Drive Fan:
1. TBI-25 Backward Incline direct drive fan designed to deliver 8,100 CFM at 10".0 w.g. total static pressure. Fan field mounts to the side of the collector. Fan Motor is 25 HP, 3450 RPM 208/230/460/3/60 TEFC premium eff. motor. Exterior surfaces are painted with a blue finish.

N. Fan Transition with Guard:
1. The fan transition with guard provides an installation bracket for mounting the above TPI fan. The transition also provides a guard to keep the objects from accessing the fan wheel from the clean air plenum of the collector.

O. Damper:

1. Volume control damper, parallel blade, is shipped loose for field installation on the fan outlet to control system airflow. The damper is manually operated with handle and locking quadrant.

P. Exhaust Silencer:
1. The exhaust silencer for the TBI fan is fabricated of painted galvanized steel and lined with absorbing materials. Noise level with a standard exhaust silencer and a 25 HP fan assembly is approximately 70 dBA measures 1 meter at AMCA position #3 and under free field conditions. The actual measuring sound level will be dependent on the background noise and installation conditions.

Q. Explosion Relief Vent:
1. Quantity (1) 18" x 35" explosion relief vent located on the side of the unit. Explosion vents limit overpressure in the event of a deflagration in order to maintain the structural integrity of the collector.

R. Ductwork (EHG Transfer System Duct or equal):
1. Material - Galvanized steel conforming to ASTM standards A653 and A924.
2. Surface Finish - G-60 galvanized steel.
3. Thickness - 22 gauge nominal (0.0296 inch standard).
4. Construction:
   a. Duct is of non-corrugated, spiral lock seam construction with a mechanical formed seam locking indentation evenly spaced along the spiral seam.
   b. Fittings shall be manufactured using one or more of the following construction methods:
      1) Overlapping edges stitch welded along the entire length of the fitting.
      2) Standing seam gore locked and internally sealed.
      3) Button punched and internally sealed.
      4) Elbows 3" through 12" diameter will be die stamped and continuously stitched welded.
   c. Available in diameters 3" through 20".
5. Connections:
   a All duct and fittings ends shall be provided with factory formed 300 rolled edge and joined externally by means of an integral latching/locking barrel clamp with a custom form fitted EPDM sealing gasket to ensure no duct penetrations or protrusions into the airstream.
6. Joint Sealing:
   a Connections are sealed by means of the transfer barrel clamp. No additional field sealant is necessary.
7. Provide specifically designed flexible hoses to connect the hard duct to each piece of equipment. Provide all necessary fittings, transitions, offsets, elbows and components for a complete connection to each piece of equipment.
8. Provide blast gated at each piece of equipment and at each floor sweep located at 6'-0" above finished floor for end point flow balancing.

S. Flexible Ductwork (Car-Mon Type NE Tubing or equal):

1. Tubing for connections to shop equipment shall be of a scuff resistant type constructed of a double ply neoprene impregnated polyester fabric hose constructed with an external wearstrip reinforced with a spring steel wire helix. Tubing shall be Car-Mon Type NE in length and diameter as shown on the drawings. Exhaust adapters, weld receptors, guide rings, flanges, etc. if required, shall be attached to the tubing at the factory to ensure the integrity of the assembly. Field assembly is not acceptable. Tubing shall be the product of US manufacturer, manufactured in the USA.

T. Floor Sweeps (Car-Mon or equal):
1. The floor sweep shall have a minimum resistance airflow design with dimensional considerations based on 4000 FPM nominal duct velocity. The floor sweep is constructed of 18 gauge galvanized steel welded construction and shall incorporate a floor mounting bracket with 3/8” diameter holes for permanent attachment. The connection collar shall be available either straight or crimped. The floor sweep shall be supplied with a built-in hinged damper with foot-operated damper door opener, including linkage pivots.

U. Manufacture: Subject to compliance with above requirements.
1. Donaldson-Torit, Inc.
2. Approved Equal.

2.13 ENERGY RECOVERY UNITS

A. Furnish and install, Cook, Munters/DesChamps or Annexair. Alternate equipment as manufactured by Deschamps Labs or Semco will be acceptable provided it meets all specified performance and physical criteria. Other alternate manufacturers shall be approved by the architect and engineer in writing at least two weeks prior to bid.

B. General:
1. Unit shall be factory fabricated. Unit manufacturer shall be responsible for provisions of fans, dampers, coils and all other unit and plenum components as specified in this section or other sections of this division and performance characteristics as shown in schedules or on drawings. Contractor designed or assembled air handling units shall not be acceptable or considered as equal.
2. Unit shall be factory-fabricated for shipping.
3. Shop drawings shall be subject to approval of the Owner and Architect.
4. Certify conformance with performance requirements specified and shown on Drawings.
5. Provide necessary appurtenances to perform as specified, whether or not expressly required by Contract Documents mentioned herein in conformance with good trade practice, as determined by Architect.
6. The factory modular units shall be constructed on a roof curb or steel dunnage provided under other sections. Mechanical Division Contractor shall carefully coordinate dimensions of air handling unit with framework or curb dimensions.
7. Unit manufacturer shall seal any casing penetrations made in field for piping, conduit, tubing and equipment installed under other sections. Advise manufacturer in advance of required field penetrations of casing.

C. Testing:
1. Test to ensure structural integrity, design suitability under simulated

operating conditions, systems operation and minimum vibration levels as specified. Certify that unit complies with design intent and Contract Documents.

2. Prior to shipping the following tests shall be performed:
   a. Pressure test water coils if coil manufacturer has not already performed pressure test, and piping.
   b. Functional test of all electro-mechanical components installed in the factory, including dampers, actuators, fans, VFD's, airflow sensors, electrical connections and wiring, and all factory-provided refrigeration systems.
   c. Operate fans at design RPM and conduct vibration assessment. Check motor and drive vibration with fan as a completed assembly. Fan, motor, drive and base assembly vibration shall be brought to within acceptable levels if required.
   d. Energize electrical devices to ensure operational integrity prior to shipment. Replace non-functioning items.
3. Submit housing panel acoustical, structural and physical properties performance test data from independent recognized test laboratory.
4. Manufacturer shall be responsible for correcting any operating deficiencies found during the unit startup after installation.

D. Unit shall comprise of, but not limited to, AHU sections shown on drawings and the following list:
   1. Double wall cabinet
   2. Outside air intake hood with louver and integral pre-filters
   3. Outside air intake plenum with damper
   4. Rotary enthalpy energy recovery wheel section with bypass dampers
   5. Recirculation Damper section
   6. Final filter section
   7. Heating coil section
   8. DX cooling coil section
   9. Heatpipe section with face and bypass dampers
   10. Supply air fan section
   11. Return air filter section
   12. Exhaust air fan section
   13. Integral ACCU section
   14. Fan motors compatible with variable frequency drives
   15. Variable frequency drives for fan motors

E. Costs associated with dimensional, performance or other deviations from the specified equipment, including engineering costs to evaluate such deviations, shall be paid by the contractor.

F. The unit(s) shall be installed in strict accordance with the specifications. Unit(s) shall be complete with all components and accessories as specified. All units shall be factory assembled, internally wired, and 100% run tested to check operation, fan and blower rotation and control sequence before leaving the factory. Wiring internal to the unit shall be numbered for simplified identification. Units shall be ETL listed and labeled, classified in accordance with ANSI-UL 1995 / CAN/CSA C22.2 No.236. Units shall be rated and ETL listed for electric heaters with single point power connection for the entire unit, up to 100kW.

G. Quality Assurance

1. All unit(s) shall be factory run tested before shipping. A proof copy of the test shall be placed in the unit electrical power & control panel. Unit(s) shall bear the ETL label, tested in accordance to UL 1995. Electrical components shall be UL listed; fans shall be tested in an AMCA certified laboratory; insulation shall comply with NFPA 90A; coils shall tested in accordance to ARI 410 and filters shall be tested in accordance to ASHRAE 52. The unit manufacturer shall have an independent testing agency test the air leakage, panel deflection and sound pressure levels for a typical unit providing at minimum the supply airflow of units in question and not exceeding 20,000 CFM. The air leakage of the unit(s) shall not exceed 1% at 10" inches H2O positive static pressure and a copy of the report must be submitted upon request. Unit shall be constructed to limit frame and panel deflection to 1/250th of the panel length at 10" inches H2O positive static pressure and a copy of the report must be submitted upon request. The unit shall also be tested in accordance with ANSI S12.34-1998 and instrumentation used must be in compliance with the requirements of AMCA 300 for sound readings. The sound tests conducted shall report overall sound power and pressure readings for supply air outlet, return air inlet and casing radiated.

H. Housing

1. The unit housing shall be constructed from a frame, base and panel assembly. Unit shall be completely factory assembled and shipped in one piece as shown on drawings. The frame shall consist of robust injection molded corners and extruded thermally broken aluminum profiles; welded together for reinforcement. Base structure shall be fully welded and have integral lifting lugs which can be removed once the unit is installed. An under-floor liner shall be provided. Unit casing must be guaranteed to have no exterior condensation at interior AHU temperatures down to 43F while unit exterior conditions are maintained at 95 F dry bulb / 85 F wet bulb.
2. All roof and wall panels shall be made from "thermo-composite" panels, with an aluminum interior and exterior liner. All panels and access doors shall be double wall construction with R14 foam insulation, and Greenguard certified®. The panel shall be capable of withstanding air pressure up to 10" w.c with 1/16" panel deflection. Panels shall be fastened from the interior and gasketed along the frame to reduce thermal transmission. Fixed panels shall be removable without affecting the housing integrity.

   Alternate construction: all roof and wall panels shall be made from aluminum, minimum .063" aluminum exterior and .063" aluminum interior. All panels and access doors shall be double wall construction with (r-12) two-inch thick, minimum 3.0 pcf polyisocyanurate foam insulation. All casing panels and frame must be provided with true thermal break.
3. Casing system shall be guaranteed to assure the owner that system capacity, performance, and cleanliness standards specified are not compromised. The panels shall be tested in accordance with SMACNA and ASHRAE 111 to have a deflection of no more than L/1150 at 10'' and withstand air pressures up to 8" w.c. Leakage to be guaranteed at no more than 1% of the design volume at 1-1/2 times the design operating pressure or 30 CFM, whichever is greater. All casing walls shall be of panel construction, including the fan discharge walls, mixing section walls.
4. Access doors shall be provided to all major components to facilitate quick

and easy access. Access doors are to be provided with open guard door locks to lock the door in the open position for safe access in windy conditions. All access door(s) shall have Allegis type latches and nylon type hinges designed to open 180 degrees. Doors shall open against air pressure as indicated on drawings. Removable panels provided for equipment pull out for coil(s) and heat exchanger(s) shall have key tooled threaded insert fasteners, and have at least one fixed handle on the outside. Access doors shall be sealed with a full "U-Shaped" gasket for superior air tightness along the door edge. Bulb type gaskets shall not be acceptable since they do not return to their original form once compressed.

5. The airflow separation wall between the outside air intake and exhaust air outlet shall be one inch double wall "thermo-composite" panels insulated with minimum R7 foam insulation and Greenguard certified®.)
6. All roof and side wall seams shall be positively sealed to prevent water and air leakage.
7. Outdoor units shall have a rain gutter above each access door and a watertight roof shall be provided with a white TPO UV-reflective membrane. The entire exterior will be finished with (2) two coats of acrylic urethane enamel, manufacturer standard color. Paint shall pass ASTM B117 3000-hour salt fog resistance test and ASTM D4585 3000-hour moisture condensation resistance test. Floor openings shall be covered with 1" fiberglass safety walk-on gratings.
8. Air handler unit casing shall be provided with a lifetime warranty against corrosion resistance under normal use.

I. Weather Hoods

1. The outdoor air hood shall be designed with a 4" extruded aluminum louver, bird screen and a plenum enclosure with drain holes. The louver blades shall be drainable type with a maximum 45 degree angle and curved with integral rain baffle. The louver design shall not allow more than 0.03 oz/ft2 water penetration when tested in accordance to AMCA 500. The pressure drop of the complete hood assembly shall not exceed 0.05"wc at a maximum 450 fpm.
2. Pre-filter rack system shall be installed within the weather hood enclosure to prevent outdoor air dust and debris from entering the damper and unit casing plenum. Filter access in the hood shall be accomplished via the louver that is installed with a stainless steel piano hinge and spring loaded latch. No tools or ladders shall be required to access the pre-filters in the weather hood assembly.
3. The exhaust air outlet louvers shall be 2" extruded aluminum, with non-restricting blade design and bird screen.

J. Enthalpy Wheel

1. Enthalpy Wheel shall recover both sensible and latent heat. The matrix shall be constructed from corrugated aluminum and specifically treated and coated with silica gel desiccant to assist and enhance latent heat transfer. Segmented wheel shall be provided on diameter sizes above 96". Seals shall be full contact, low bleed type, made from dual band Ultra High Molecular Weight Polyethylene. Any seal that is non-contact is not to be considered a seal and will not acceptable. Labyrinth type seals do not operate properly under different air stream pressures therefore shall not be acceptable in any circumstances. Drive system shall be operated by a fractional horsepower motor (maximum 1 HP), reducing gear-box, pulley

and v-belt. Belts shall be made of multi link high-tech urethane/polyester composite. The wheel bearing shall be permanently sealed and press fitted into the wheel matrix for long life operation. A double purge sector (2 x 5º) shall be factory installed to reduce cross contamination to under 0.04%. Frost control prevention shall be accounted for if outdoor air temperatures are below 10 degrees F at equal airflows and return relative humidity below 30%. Frost control shall be accomplished by a variable speed drive and controlling the leaving air condition of the exhaust air. Other methods of frost control will not be considered for this application. Wheel speed shall not rotate faster than 20 rpm. Any rotational speed above 20 rpm will be unacceptable. Media cleaning shall be accomplished with any of the following methods: compressed air, low pressure steam, hot water or light detergent without degrading the latent recovery.

a. Warranty: A standard 5-year material and labor warranty shall be provided covering all materials supplied and installed

K. Energy Recovery Heat Pipe

1. Air to Air Heat 3D Loop Energy Recovery Heat Pipe to be supplied by Heat Pipe Technologies (HPT), Tampa FL, to exchange heat/cooling between two air streams without changing the physical attitude of the heat pipe to accommodate summer or winter. The Heat Pipes shall be inside and integral to the equipment cabinet.
2. The tubes shall be copper, of specific design for Heat Pipe application, permanently expanded onto the fin collar to form a firm, rigid, and complete pressure contact at all operating conditions. The Heat Pipes shall be constructed of heat transfer modules that are UL listed. Aluminum tubes will not be allowed.
3. The fin surface shall be continuous plate type, aluminum fins of specific design to produce maximum heat transfer effectiveness for Heat Pipe applications. Airside pressure loss shall be as given on the schedule or otherwise specified. Fin density and the number of rows of tubes shall be as specified.
4. Heat transfer fluid shall be selected on the basis of operating temperature and compatibility with tube material and shall be classified as Safety Group A1 in BSR/ASHRAE Std 15-1989 R. Refrigerant shall be R-410A.
5. Heat pipe effectiveness and air pressure drop shall be as scheduled. Airflow through the heat exchanger shall be in a counter flow pattern to ensure maximum performance. No parallel or cross flow heat exchangers will be accepted. Heat exchangers requiring moving parts are not acceptable. Tilting of the heat pipes shall not be required or allowed for heat transfer.
6. The frames and mounting structure shall be minimum 16 gauge galvanized steel.
7. An isolation partition shall be provided between the supply and exhaust airstreams. The copper tubes carrying the Heat Pipe working fluid must be expanded into the mating holes in the dividing plates assuring an excellent seal to prevent cross contamination. The center partition shall have single galvanized steel dividing plate.
8. Heat Pipe interconnecting piping and circuitry shall be as specified by HPT design. Each circuit shall be individually processed, charged, and hermetically sealed.
9. Face and bypass dampers shall be provided on both sides of the heat pipe

to allow full modulation of heat gain through the heat pipe. Dampers shall be provided with modulating actuators.

L. Fans

1. The fans shall be carefully positioned and installed at an optimal distance to respect uniform airflow across the heat exchanger & coil(s).
   a. Plug Fans: Fans shall be direct drive radial centrifugal fans with free running impeller. No fan belts will be acceptable for this application. Fans shall be compact, optimized and construction made of galvanized sheet steel with backward curved 7-blade high efficiency impeller, protected by an epoxy powder coating. To reduce vibration, the impeller shall be balanced with hub to an admissible vibration severity of less than 2.8 mm/s in conformity with DIN ISO 14694 and proof shall be supplied for each individual impeller. Tests shall be made according to DIN ISO 1940 Part 1, quality of balancing G2.5/6.3. The single inlet shall be mounted onto constant speed direct drive motor, equipped with an air flow optimized inlet cone from galvanized sheet steel. Fans shall have maintenance free ball bearings, closed on both sides, sealed for life. Fans shall be completely certified as per ISO 5801 and in accordance to AMCA standards. Fans will require to be operated by a Variable speed drive. Plug fan shall come equipped with guard grills for the air intake side.
   b. The unit manufacturer shall provide flexible connection between fan and fan wall. Flex connection material shall be flame retardant fabric suitable for intended use meeting the requirements of NFPA 90A.
   c. The fan and motor shall be factory-mounted on a welded structural steel spring type vibration base. The base shall be mounted on stable / adjustable, seismically restrained (seismic zone 2) isolators with 2” maximum deflection rating. Spring efficiency to be not less than 98%.

M. Fan Motors

1. The fan motors shall meet NEMA standard dimensions and comply with the Energy policy Act of 1997. Motors shall have high efficiencies with low noise and vibration output. Motors shall be certified and built in accordance to ISO 9001 quality control system.
2. Motors shall be 1750 or 3600 RPM, 460V/3ph/60 Hz as scheduled and as per the following:
   a. Motor shall be premium efficient, ODP enclosure, with cast iron housing and end bells.
   b. Motor shall be of HP as listed on schedule and be selected for a minimum of 10% over calculated BHP. The motor service factor shall be a minimum of 1.15.
   c. Motor shall be designed for continuous duty operation, NEMA Design B with Class F insulation.
   d. The motor shall be suitable for operating with variable frequency drives without undue noise, vibration or deterioration of reliability and life.
   e. Provide stainless steel nameplate indicating the following:
      - NEMA efficiency index nominal efficient (MB1-12.53BO).

- AFBMA bearing numbers.
- Lubrication instructions.

f. Acceptable motor manufacturers: Reliance, General Electric, Baldor.

N. Fan Airflow Measurement and Control System

1. Provide the EZ Balancer fan air flow measurement system with fan inlet bell air flow measuring taps, electronic controller with digital display of cfm for each fan and transducer.

O. Variable Frequency Drive (VFD)

1. The VFD shall use Insulated Gate Bipolar Transistor (IGBT) technology to convert three phase input power to coded Pulse Width Modulation (PWM) output. The VFD shall be equipped with easy access function for the most frequently used parameters in HVAC applications. The VFD keypad shall have door mounted status indicators. The VFD shall have monitoring functions to monitor VFD during motor operation. The VFD shall have a carrier frequency that is able to switch the IGBT at 15 kHz. The power terminal strip shall have at least (8) eight digital programmable input terminals. The VFD shall also have programmable output terminals. The VFD shall have 4-20mA analog output terminals that are fully programmable. The VFD shall have the ability to retry automatically after a fault. In the event of a momentary power failure the VFD shall read the inverter speed and direction of a coasting motor and shall restart the motor smoothly. The drive shall have electronic thermal protection settings to protect the motor. The VFD shall have PID function for constant flow applications. The VFD manufacturer shall provide at no charge phone support on VFD. In addition to that, every VFD smaller than 20 hp shall be available in either extender box or integrated enclosure configuration. VFD larger than 20 hp shall be mounted in an integrated enclosure only including the power unit, contactors, relays, and all specified accessories. VFD's shall not have "by-pass" for direct driven fans since they may damage the unit if the motor rpm is higher than the actual rpm required.

P. Filters

1. Pre-Filters (Maxi Pleat 2" MERV 8 (25-30%)).
   a. Filters shall be factory installed upstream of the heat exchanger and coils, in both airstreams. The air filters shall be Filtration Lab's Maxi-60 MERV 8. Each filter consist of 100% synthetic media, expanded metal on the downstream and enclosing with high wet-strength beverage board with diagonal support bonded on air entering and air exiting side of each pleat. MERV 8 model 415 FILTERS, u.l. class 2 are rated as per ashrae test 52.2.1999 at 55% efficiency initial (based on Minimum Average Efficiency) at 3-10 microns. The model 415 could be operated at 500 fpm, surface area 17.6 FT2 of media based on 24 x 24 x 2 initial static pressure at 0.28" final will be 1". Filters shall be placed in a completely sealed, galvanized holding frame with quick release latches for easy replacement.
2. Final (Mega-Pak 4" MERV 13 (85%)
   a. Filters shall be factory installed where shown on the drawings. The air filters shall be Filtration Lab's Mega-Pak MERV 13. Each filter

shall consist of 100% synthetic media, expanded metal on the downstream and enclosing frame shall be constructed of a rigid galvanized steel to provide a durable housing for the filter pack. The filter shall have a steel reinforced diagonal support braces affixed on both sides of the filter and it shall have plastic fingers for affixed on both sides of the media pack to control spacing as well to prevent the pleat rows from collapsing one upon the other.

3. Filter Gauge
   a. Unit manufacturer shall provide and install a Dwyer series 2000 magnehelic gauge complete with stainless steel static pressure tips and accessories for indicating the operating pressure drop of each filter bank. Indicating range of gauge shall be selected at two times the final resistance of the filter bank. The filter gauge shall be mounted on the unit exterior

Q. Dampers
1. Dampers shall be installed where shown on the drawings. Dampers shall be low leak type with rubber edges, opposed or parallel blades, and constructed from extruded aluminum. Galvanized dampers will not be acceptable.
2. Dampers shall be installed in the following compartments with linkage rod for actuators.
   a. Outdoor air intake, with modulating actuator
   b. Recirculation air damper, with modulating actuator, fail open
   c. Enthalpy wheel bypass dampers (supply and exhaust), with 2 position actuator
   d. Heatpipe face and bypass dampers, with modulating actuators (face fails open)
   e. Exhaust outlet, with 2-position actuator
3. Actuators shall be 24V factory installed; two-position or modulating type as indicated above. All actuators shall have spring return mechanism and auxiliary switches.
4. <u>Dampers will be installed in the failed close position unless otherwise noted.</u>

R. Hot Water Heating Coils
1. Hot water coils shall have 5/8" O.D., 0.035" thick copper tubes with helically wound 0.008" thick aluminum fins by Aerofin, Heatcraft or Marlo.
   a. Casing shall be 16-gauge galvanized steel.
   b. Headers shall be steel barrels with vents, drains, and serpentine continuous tube design, suitable for 200 psi working pressure.
   c. Coil fins shall be flat or rippled fin design, .0075" aluminum. Air pressure drop scheduled shall not be exceeded.
2. Coils shall be housed in factory-fabricated frame independent of unit casing. Coil frames shall be 12-gauge stainless steel.
   a. Coil frames shall support coil sections independently allowing coil to be removed through exterior unit casing, normal to direction of air flow, without disturbing other coil sections.
   b. Coil casing shall have removable panel on exterior side.
3. All coil pipe connections shall be individually extended through the unit casing wall. Pipe headers and all piping specialties are to be provided in the field by the Contractor. Drain and vent connections shall be piped with ball

valves and hose bibs for the drain.

4. Coils shall be tested to 250 psig under water and shall be guaranteed for 200 psig working pressure.

S. DX Cooling Coils

1. DX coils shall have 3/8" O.D., 0.025" thick copper tubes with 0.008" thick aluminum fins by Aerofin, Heatcraft or Marlo.
   a. Casing shall be continuous stainless steel.
   b. Headers shall be steel barrels with vents, drains, and serpentine continuous tube design, suitable for 200 psi working pressure. Headers shall have intruded tube holes to provide a large brazing surface for maximum strength and inherent flexibility.
   c. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates.
2. Coils shall be housed in factory-fabricated frame independent of unit casing. Coil frames shall be 12-gauge stainless steel.
   a. Coil frames shall support coil sections independently allowing coil to be removed through exterior unit casing, normal to direction of air flow, without disturbing other coil sections.
   b. Coil casing shall have removable panel on exterior side.
3. Each coil tier shall have a welded 16-gauge stainless steel condensate drain pan extending at least 6" in direction of air flow individually piped to unit pan. Provide a minimum pan depth of 3". Pans shall be triple sloped IAQ type.
4. All coil pipe connections shall be pre-piped at the factory by the manufacturer. Drain and vent connections shall be piped with ball valves and hose bibs for the drain.
5. Coils shall be tested to 250 psig under water and shall be guaranteed for 200 psig working pressure.
6. All coils shall be certified in accordance with ARI standard 410.

T. Condenser Coil

1. Unit condenser shall incorporate microchannel coil(s) entirely constructed of aluminum.
2. Condenser coil(s) shall be protected against debris, insects and hail using a removable nylon screen with tool-free quick latches.

U. Air Cooled Condensing Unit

1. Provide integral variable capacity through variable speed compressor air cooled condensing section. The condensing unit shall be factory piped, wired, and ready for field installation and charge with R-410A refrigerant. Each compressor shall be equipped with a crankcase heater function, anti-short cycling and a variable frequency drive (VFD) which includes a built-in phase loss detector.
2. Unit manufacturer shall have at least five (5) installations utilizing variable speed compressors.
3. Each compressor shall be Danfoss variable speed scroll type that can modulate from 30 to 90 Hz mounted on rubber isolators and vibration absorbers. Each compressor shall be equipped with a variable frequency

drive (VFD) which includes built-in phase loss detector, crankcase heater function and anti-short cycling.

4. Refrigeration circuits quantity shall be as follows: 22T: one, 30 to 46T: two, 58 to 70T: three, 84T: four.
5. System design shall be head pressure control type. Compressor(s) and all condenser fans shall modulate to maintain supply setpoint within ± 0.2°F.
6. Unit PLC logic shall be factory programmed to send signals to control the condensing modulation without field adjustments.
7. System design with hot gas by-pass is not acceptable.
8. All condenser fans shall be constructed with die cast aluminum 7-blades with a 6" minimum bell-mouth height. Protective guards shall be included. All condenser fans shall have an asynchronous external motor type, insulation class F, IP54 and 100% variable speed.
9. Sound power levels of each condenser fan should not exceed 86 dB at maximum speed.
10. System shall be equipped with a thermal expansion valve, filter drier, sight glass, solenoid valve, low & high pressure control.
11. All refrigeration parts, including compressor(s) shall be installed in a closed vented service compartment separate from unit airflow. Open air refrigeration systems will not be acceptable.
12. Circuit(s) with HRGC shall be equipped with a receiver.
13. At any time, water shall be evacuated outside from the condensing unit section.
14. Controls shall include: automatic compressor lead/lag control, compressor minimum off time (5 min), capacity control with variable speed compressors and alarm relay out to indicate when the unit is in alarm condition. All refrigeration parts, including compressors shall be installed in a closed vented service compartment separate from the condenser coil airflow. Each refrigeration system shall be factory tested.
15. Minimum (5) five year compressor warranties shall be provided.
16. Compressors shall be provided complete with sound blanket. Blanket construction shall be a teflon impregnated cloth and loaded vinyl noise barrier, the blankets shall be custom-fit to encapsulate the compressor, minimize air voids and block sound at the source. The blanket shall reduce the compressor noise by minimum 40%+ and/or 8.5 dB at ARI conditions.

V. Seismic Spring-Isolated Roof Curb

1. A non-insulated, pre-fabricated seismic rated adjustable spring isolation roof curb shall be provided.
2. Curbs shall be full perimeter construction using structural steel tubing for the upper and lower members. The lower frame must accept point support for both seismic attachment and leveling. The upper frame must be designed with positive fastening provisions (welding or bolting), to anchor the rooftop unit to the curb, which will not violate the National Roofing Contractors Association (NRCA) ratings of the membranes waterproofing. Contact points between the rooftop unit, the curb and the building structure shall show load path through those locations only.
3. The curb shall consist of a rigid lower member with properly spaced, fully adjustable spring pockets that allow for removal or replacement of the spring after installation. Lower member of curb shall contain provisions for supporting field installed insulation panels. Curb shall contain perforated material to allow for insulation to absorb airborne noise and a wood nailer for

attachment of roofing material. Curb shall have a continuous structural upper member. A flexible waterproofing membrane shall be supplied to span between the upper and lower sections of the curb. Flashing shall be provided to allow for protection of the waterproof membrane and roofing material edging. A continuous gasket shall be provided to be applied to the top member. Curbs shall be capable of being point supported from the building structure.

4. Curb shall contain pre-welded duct supports.
5. Curb shall have provisions to positively attach the equipment for wind and seismic loading. Spring pockets shall be certified to support all wind and seismic loads applied to the unit. Pocket shall include a functional neoprene bushing to absorb impact, with a maximum of 0.25" air gap prior to contact3
6. Curbs shall have a minimum operating height as indicated on the schedule.
7. Contractor to line the bottom of the curb pocket with at least 2 layers of 5/8" waterproof sound board, taped to keep it in place.

W. Electrical

1. All electrical and control components shall be wired into a NEMA4 electrical panel and shall be single point power connection.
2. Electrical panel shall include:
   a. High & low voltage wiring with fuse protection
   b. All variable frequency drives
   c. 24 Volt transformers
   d. Lockable non-fused disconnect switch
   e. Laminated electrical, controls and refrigeration diagrams
   f. Air vent to evacuate excess heat
   g. A separate wiring pipe chase for low voltage and high voltage
   h. A drain shall be included in the electrical compartment

X. Controls

1. All controls except those listed above (ACCU controls, fan motor speed control, wheel speed control, fan airflow measurement and damper actuators) to be by ATC contractor.

Y. Service Power & Lighting

1. GFI, lights and switches shall be factory installed and wired to a common junction box. A separate power connection 120/1 will be required (powered by others).
2. Marine Light
   a. A marine light shall be included in the supply fan compartment.

Z. Warranty

1. Manufacturer warrants each product to be free from defects in material and workmanship under normal and proper use, and will within twelve (12) months from date of start up and not exceed eighteen (18) months from shipment, repair or replace any part which, when returned to our factory transportation charges prepaid, and upon inspection by manufacturer, proves to be defective. This warranty does not include any labor or service charges that occur under this warranty. Minimum (5) five year wheel and compressor warranty shall be provided, parts only. Unit casing shall be provided with a lifetime warranty against corrosion. The installing contractor must be responsible for warranty service and maintenance after the equipment is placed into operation.

AA. Equipment Start-Up

1. The equipment start-up and operational check out is the responsibility of the mechanical contractor who purchased the equipment and associated personnel responsible for its operation. Manufacturer must provide a factory-trained technician who will provide Start-Up Supervision. A written request for Start-Up Supervision must be received a minimum of 2 weeks before expected start-up date in order to schedule it. The mechanical contractor must supply personnel, tools, gauges and instruments to run the equipment. The personnel responsible for the operation of the equipment (installing contractor and controls contractor) must be present for the start-up.

2.14 EXPANSION JOINTS

A. Expansion joints shall be provided where indicated on the drawings. Equipment shall be as manufactured by Advanced Thermal Systems, ADSCO Division of Yube Industries or approved equal.

B. Expansion joints shall have internal and external guides, fabricated steel body with 150 psig service ratings, single or double slide arrangement to suit the installation location. Bases shall be provided for mounting on framing or to other framing structure. Joints shall have flanged pipe ends on all sizes, polished duplex chrome/nickel plated sleeve sections and entire unit shall be provided with external packing application connections for addition of lubricant under full line pressure. Provide proper packing for both hot and cold lines, together with sufficient spare material and applicator for one year period.

C. Provide guides for expansion joints on the movement side of each expansion joint. Two guides shall be provided prior to each moveable section of expansion joint. Guides shall be ADSCO Model H, for high temperature and Model H-1TB for low temperature lines. Guides shall be located as recommended by the expansion joint supplier for his equipment to minimize lateral misalignment.

D. Provide fintube compensators where indicated on the drawings or every 50 feet on straight fintube runs. Compensators shall be enclosed bellows type with internal guides.

2.15 EXPANSION TANKS

A. Expansion tanks shall be of the types, sizes and capacities indicated on the drawings. Equipment shall be as manufactured by Taco, Bell and Gossett or Thrush.

B. Equipment shall be designed for 125 psig ASME working pressure and so labeled. Tanks shall be provided with gauge glass with tricocks and drain, tank drain, charging valve and mounting saddles or cradles.

C. Bladder-type tanks shall be designed for 125 psig ASME working pressure and be so labeled. Tanks shall be provided with tank drain, charging valve, replaceable bladder, lift ring and base support or cradle. Acceptance capacity shall be the capacity scheduled

2.16 FANS (CENTRIFUGAL)

A. Centrifugal fans mounted in ceiling, wall or with inline duct configuration shall be of the sizes and capacities indicated on the drawings. Fans shall be centrifugal type manufactured by Cook, Greenheck, Acme or Penn Ventilator Company.

B. Fans shall be provided with damper and adapter kit for installing fan with an inline arrangement, where applicable a wall vent, or roof vent cap for installation on an insulated curb provided by the HVAC sub-contractor.

C. Provide solid state controller to allow full range control of fan speed.

2.17 FAN (FUME HOOD EXHAUST)

A. General

1. Base fan performance at standard conditions (density 0.075 Lb/ft3).
2. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.
3. Each fan shall be belt driven.
4. Fans to be equipped with lifting lugs.
5. Fan to be coated steel with a minimum of 4 mils of Hi-Pro Polyester Resin. Color to be gray.
6. Fasteners to be stainless steel.
7. Fan assembly shall be designed for a minimum of 125 MPH wind loading, without the use of guy wires.

B. Fan Housing and Outlet

1. Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
2. Fan housing shall be welded steel with a minimum of 4 mils of Hi-Pro Polyester Resin. No uncoated metal fan parts shall be acceptable.
3. Fan housings that are fabricated of polypropylene or fiberglass that have lower mechanical properties than steel, have rough interior surfaces in which corrosive, hazardous compounds can collect, and / or which chalk and structurally degrade due to the UV component of the sunlight shall not be acceptable.
4. A high velocity conical discharge nozzle shall be supplied by the fan manufacturer and be designed to efficiently handle an outlet velocity of up to 6000 FPM. Discharge stack caps or hinged covers, impeding exhaust flow shall not be permitted.
5. Provide housing drain for removal of rain and condensation.
6. A bolted and gasketed access door shall be supplied in the fan housing allowing for impeller inspection or removal of impeller, shaft and bearings without removal of the fan housing.
7. Standard finish color to be gray.

C. Fan Impeller

1. Fan impeller shall be centrifugal, backward inclined, with non-stall characteristics. The impeller shall be electronically balanced both statically and dynamically per AMCA Standard 204.

2. Fan impeller shall be manufactured of aluminum (AMCA type B spark resistant), fully welded and coated with a minimum of 4 mils of Hi-Pro Polyester resin.

D. Fan Bypass Air Plenum

1. For constant volume systems, the fan shall be connected directly to the exhaust duct without the need of a bypass air plenum.
2. Fan designs that use inlet flexible connectors that can leak causing loss of lab exhaust shall not be accepted.
3. A fan isolation damper shall be two-position motor actuated, fabricated of steel or aluminum and coated with minimum 4 mils of Hi-Pro Polyester resin, electro-statically applied and baked, shall be provided as shown on the project documents.
4. Blower / Plenum vibration isolation shall be limited to neoprene / cork vibration pads.

E. Fan Motors and Drive

1. Motors to be premium efficiency, standard NEMA frame, TEFC with a 1.15 service factor. A factory mounted NEMA 3R disconnect switch shall be provided for each fan. Motor maintenance shall be accomplished without fan impeller removal or requiring maintenance personnel to access the contaminated exhaust components.
2. Drive belts and sheaves shall be sized for 150% of the motor horsepower, and shall be readily and easily accessible for service, if required. Drive shall consist of a minimum of two belts under all circumstances.
3. Shaft to be polished and ground steel.
4. Fan shaft bearings shall be Air Handling Quality, ball or roller pillow block type and be sized for an L-10 life of no less than 100,000 hours. Bearings shall be fixed to the fan shaft using concentric mounting locking collars, which reduce vibration, increase service life, and improve serviceability. Bearings that use set screws shall not be allowed.
5. Bearings shall have extended lube lines with Zerk fittings.

F. Manufacturer

1. Greenheck Fan Corp, Model Vektor-H High Plume Laboratory exhaust system, Cook, Penn Ventilator, Acme or approved equal.

2.18 FANS (ROOF)

A. Roof exhaust fans shall be of the centrifugal belt-driven or direct-drive type as indicated on drawings. Fans shall be of capacities and characteristics as scheduled on drawings and specified herein. Fans shall be as manufactured by Greenheck, Cook or ACME.

B. Construction of the fan housing shall be of heavy-gauge aluminum.

C. All spun parts shall have a rolled bead for added rigidity and shall be specially spun so as to seal the pores of the aluminum providing greater resistance against oxidation and deterioration.

D. The fan wheel shall be all-aluminum of the centrifugal blower type featuring backward-inclined blades and a tapered inlet shroud. Wheels shall be statically and dynamically balanced. Inlet cone shall be aluminum and of the centrifugal blower type. Motor and drives shall be enclosed in a weathertight compartment, separate from the exhaust air stream. Air for cooling the motor shall be supplied to the motor compartment by way of an air passage from an area free of contaminated exhaust fumes. Motors shall be of the duty, permanently lubricated, sealed ball-bearing type. Drives shall be sized for 165 percent of motor horsepower capabilities and of the cast-iron type, keyed to the fan and motor shafts. Variable pitch drives shall be standard. Fan shall be of steel construction, turned, ground, and polished to precise tolerances in relationship to the hub and bearings. Drive belts shall be of the oil-resistant, non-static, non-sparking type with life expectancy of 24,000 hours.

E. Bearings shall be flanged and of the permanently lubricated, permanently sealed, ball-bearing type capable of over 200,000 hours bearing life. The entire drive assembly and wheel shall be removable as a complete unit, from the support structure without disassembling the external fan housing. The complete drive assembly shall be mounted on rubber vibration isolation.

F. Direct drive units shall be of identical construction as belt drive units, except for drives, belts, and fan shaft bearings.

G. Fans shall be licensed to bear the AMCA ratings seal for air and sound performance.

H. Fans shall be furnished with pre-fabricated 18 inch high roof curbs. Roof curbs shall have 2 inch raised cant strip and wood nailer. Curb shall be aluminum construction with all seams continuously welded the entire length. Curbs shall meet the one “G” acceleration criteria. Fans shall be furnished with automatic motor operated damper.

I. Provide solid state speed controller as a disconnect for direct drive fans, pre-wired and mounted. Provide pre-wired and mounted disconnect switch on belt drive fans.

2.19 FANCOIL UNITS

A. Furnish and install fancoil units where shown on the drawings and to the sizes and capacities as indicated in the schedule. Fancoil units shall be as manufactured by Trane, Nailor, Carrier, Airtherm or approved equal.

B. Performance Data:
1. Unit capacities shall be certified in accordance with ARI Standard 441-70.
2. Units shall be sound tested and rated in accordance with ARI Standard 443-70.
3. Unit shall comply with National Electrical Code and approved by Underwriter’s Laboratories.

C. Basic unit includes chassis, coil, heavy-density faced-glass fiber insulation, air block-offs around coil, removable fan board/drain pan assembly, auxiliary drain pan, fan, fan housing, motor and filter. Chassis shall be of galvanized steel of molded, high impact thermoplastic with solderless connection (7/8 inch OD copper tubes). Unit shall have one-piece box construction pedestal base riveted to chassis.

D. Coils: 5/8 inch OD seamless copper tubes mechanically bonded to configurated aluminum fins with continuous fin collars and sleeved coil end supports. Maximum

working pressure 300 psig, factory burst test 450 psi (air) and leak test 300 psi (air under water). Maximum entering water shall be 275 degrees F. Coils shall have female sweat connections to accept 5/8 inch OD copper tubing.

E. Auxiliary Heating Coils (L): 7/16 inch OD copper tubes mechanically bonded to configurated aluminum fins with continuous fin collars and sleeved end supports. Maximum working pressure 200 psig. Maximum entering water 220 degrees F. Female sweat connections to accept 1/2 inch OD copper tubing.

F. Drain Pans: Vertical main drain pans shall be galvanized steel with molded, one-piece self-extinguishing polystyrene foam insulating liner.

G. Fans: Fan wheels centrifugal forward-curved, double width of molded, reinforced glass fiber material. Fan wheels and housings corrosion resistant. Fan housings of formed sheet steel.

H. Motors: High efficiency permanent split capacitor motors shall not exceed scheduled amperage, shall have integral thermal overload protection and start at 78 percent of rated voltage. Motors shall operate satisfactorily at 90 percent of rated voltage on all speed settings and at 10 percent over voltage without undue magnetic noise. Temperature rise by winding resistance method shall not exceed 60°C. (shaded pole) and 50°C (psc) on high speed and 65°C. (shaded pole) and 55°C. (psc) on reduced speeds.

CFM	AMPS AT HIGH SPEED
200	0.55
300	0.60
400	0.55
600	0.80

All motors shall be factory run tested in assembled unit prior to shipping.

Motor cords shall be quickly detachable at switch box by locking prolonged connector (optional on horizontal units).

I. Filters: Concealed from sight and removable without displacing front panels. Filters shall be 2” MERV 13 throw-away type.

J. Extended Motor Oilers: Plastic tubes shall terminate beneath discharge grille of vertical cabinet models. Tube openings shall be covered.

K. Piping Package: The piping package shall be arranged to pipe the two coils from the same end. Piping package shall be complete with four stop valves and automatic air vents for each coil. Piping package shall be completely factory mounted including two (2) three-way control valves of same manufacture as the automatic temperature control system.

L. Controls: Each unit shall have a factory-mounted and wired three-speed on/off switch.

2.20 FILTERS

A. MERV 11

1. Air Filters shall be Model Pre Pleat 62RM11 panel filters, as manufactured by Flanders Precisionaire or approved equal.
2. Each filter shall consist of an electrostatically charged synthetic only media, with corrosion-resistant expanded metal backing and moisture resistant enclosing frame. The filter shall be 1”, 2” or 4” nominal depth. The grid shall be 100% bonded to the media on the air exiting side to eliminate media vibration and pull away.
3. The grid shall be formed to provide a uniform V-wedge shaped pleat with the open area on the air exiting side for maximum utilization of the media and low airflow resistance. The filter shall be classified for flammability by Underwriters Laboratories, Standard 900 as Class 2.
4. The filter shall have a Minimum Efficiency Reporting Value of 11 by ASHRAE Standard 52.2.

B. MERV 13

1. Air Filters shall be Model Dominator High Efficiency Rigid Cell Extended Surface Filter, as manufactured by Purolator or approved equal.
2. Each filter shall consist of 100% synthetic media. The cell sides shall be high strength, high impact polystyrene plastic and the entire filter shall be completely incinerable. The filter shall be 4” nominal depth.
3. The filter shall be classified by Underwriters Laboratories, Standard 900 as Class 1.
4. The filter shall have a Minimum Efficiency Reporting Value of 13 by ASHRAE Standard 52.2.

2.21 FOUNDATIONS AND SUPPORTS

A. All mechanical equipment and systems shall be substantially supported without distortion or excessive vibration. The methods of support shall be as hereinafter described, except as otherwise noted on the drawings. This Contractor shall locate all equipment bases and shall provide all anchor bolts and templates to the General Contractor who shall form and set all concrete work and shall set all anchor bolts. Anchor bolts and nuts shall be galvanized.

B. Concrete housekeeping pads shall follow equipment plan shape and be 6 inches in height. Where equipment is set directly on housekeeping pads the space between equipment base and pad top shall be filled by the General Contractor with non-shrinking grout. Where equipment shape or mounting is such as to require an air space between equipment bases and pad, the pad shall then be furnished with a smooth troweled surface. All equipment shall be anchored to housekeeping pads or all intervening vibration isolator bases shall be anchored to the structure.

C. Where steel frame floor supports are indicated to be provided, such framing shall be all-welded type with two coats of red primer. The framing system shall be substantial type with members sized to prevent equipment distortion or excessive vibration. Framing shall be simple post and beam box type with diagonal bracing to prevent lateral movement. Beam members shall be positioned to align with equipment support points for proper bolting and posts shall be positioned to prevent excessive beam cantilevering. Posts shall be provided with baseplate anchored to the structure.

D. Where steel framing supports are indicated to be provided for roof mounted equipment (those without integral curbs for setting into roof structure) the same framing system as described above shall be used, except members shall be galvanized and bolted together. Posts shall be positioned to align both framing and roof structural members with pitch pockets at roof penetrations.

E. Ground-mounted equipment shall be supported with framing system similar to roofing application described above except that posts shall be set on poured-in-place concrete piers with galvanized anchor bolts. Concrete piers shall be provided by the General Contractor.

2.22 GRAVITY VENTILATORS

A. Gravity ventilators shall be roof mounted air intake louver houses as manufactured by Cook, Greenheck, or Penn Ventilator Company.

B. Louver houses shall have heavy gauge extruded 6063-T5 aluminum blade of the storm blade style with corners metered and welded. Roof and curb caps shall be formed of minimum 0.051 gauge aluminum unit base to be minimum 0.080 gauge. The entire assembly braced by heavy mill gauge galvanized steel interior upright angles at the corners and along the sides. Manufacturer's catalog ratings shall be based upon tests conducted in an industry approved testing laboratory with air volumes and losses as shown.

C. Per ANSI-A58.1 testing standards, each ventilator must be rated for 100 MPH wind load and 101.5 lbs. per square foot snow load.

D. Furnish 1/2" thick sprayed on plastic coating to eliminate condensation on underside of roof. Intake ventilators to be 200% free area. Relief vents to be 150% free area.

E. All seams to be continuously welded. Equip all ventilators with aluminum bird screen.
   1. Provide a roof curb of matching construction details, coordinated with the roof construction within which it is to be installed. Curb shall be equipped with a two position, electrically driven damper at the integral utility shelf within the curb, for each gravity ventilator.

F. Provide entire aluminum assemblies in three-coar, fluoropolymer color, to be selected by the Architect from manufacturer's standard range of colors and gloss.
   1. Surfaces to be acid chromate-fluoride-phosphate pre-treated.
   2. Provide manufacturer's standard three-coat, thermo-cured system composed of specially formulated inhibitive primer, fluorocarbon color coat and clear fluorocarbon topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinyl resin by weight; complying with AAMA 605.2.
   3. Provide with five (5) year warrantee.

2.23 HOT WATER REHEAT COILS

A. Hot water reheat coils shall be of the sizes and capacities indicated on the drawings. Coils shall be as manufactured by Heatcraft, McQuay, Trane or Carrier.

B. Coils shall be ARI rated and suitable for 250 psig test pressures.

C. Coils shall be constructed with welded steel headers, staggered copper tubes with spirally wound mechanically bonded aluminum fins. Coils shall be provided with mounting flanges for insertion into the ductwork. Independently support all coils.

2.24 INSULATION MATERIALS (GENERAL REQUIREMENTS)

A. All insulation materials to be furnished for installation under this section shall be as manufactured by Owens-Corning, Certainteed, Knauf, or Schiller Company.

B. Shop drawings shall be submitted for all insulation system materials to be furnished for installation under this section. Submittals shall include descriptions of the application of all materials to be used for each insulation class and catalog cuts of all materials furnished.

C. All insulation materials to be furnished for installation under this section shall conform to fuel contributed flame spread and smoke developed limits set forth in NFPA Standard 90A as determined by NFPA 255, ASTM E84 or UL723 tests.

2.25 INSULATION MATERIALS (EQUIPMENT)

A. Equipment shall be insulated as specified and as indicated on the drawings.

B. Insulation shall be applied to equipment in accordance with insulation class. Thickness and special jacketing indicated below.

Hot water heat exchangers, hot water expansion tanks, and hot water air separators shall have 1½ inch thick Class 142 insulation.

Chilled water expansion tanks, chiller chilled water boxes shall have 1½ inch thick Class 141 insulation.

Chilled water pumps shall have 2 inch thick Class 141 insulation segmented to permit pump servicing without damaging insulation. Hot water pumps shall have Class 141 insulation same as chilled water pumps.

<u>Class 141</u>
Insulation shall consist of minimum 6 pound rigid fiberglass blocks cut to fit equipment shape and secured with 1/8 inch annealed steel wire anchored with pins attached to equipment surface to prevent sagging.

Over insulation tightly stretch wire lath, wired and anchored securely in place with all edges tied to prevent lifting and separating. Over lath apply 1/2 inch thick insulating cement plaster in two coats consisting of scratch and troweled smooth finish coat. Finish shall consist of two (2) 1/8 inch thick coats of vapor seal adhesive with intermediate glass fabric reinforcing with smooth finish.

<u>Class 142</u>
Insulation shall consist of minimum 6 pound rigid fiberglass blocks cut to fit equipment shape and secured with 20 gauge annealed steel wire or bands. Voids and seams shall be filled using insulating cement. Over insulation tightly stretch wire

lath, wired and anchored securely in place with all edges tied to prevent lifting and separating. Over lath apply 1/2 inch thick insulating cement plaster in two coats consisting of scratch and troweled smooth finish coat. Finish shall consist of 6 ounce canvas jacket trimmed to fit, tightly wrapped, sized and secured with lagging adhesive.

2.26 INSULATION (PIPING)

A. Piping systems shall be insulated as specified herein and as indicated on the drawings.

Fluid	Fluid Temp. Range F.	Run-outs Up to 1"	≤ 1.5"	> 1.5"	Class
Hot Water	105-200	1/2	1½	2	104
Chilled Water	40-55	1/2	1½	1½	104
Coil Drains	Any	3/4	3/4	3/4	Inside 104 Outside 107

Run-outs not exceeding twelve (12) inches in length

Note: Provide 0.016 inch thickness embossed aluminum protective jacketing on all insulated piping within mechanical rooms within 6 feet of floors.

B. Insulation shall be omitted from the following piping:
1. Equipment vent piping.
2. Equipment drain piping beyond shut off valve.
3. Compressed air piping.
4. Piping within fintube covers.

C. Engine exhaust piping, fittings and silencers shall be covered with 4 inch calcium silicate insulation. Insulation shall be applied in two (2) layers with staggered joints. Secure insulation in place with heavy gauge stainless steel bands. Seal all seams and joints in each layer with high temperature cement. Cover insulation with reinforced glass fiber cloth.

<u>Class 104</u>
Piping: Insulation shall consist of high density (minimum #4) molded fiberglass sectional pipe insulation with a minimum R value of 4.0 H. degrees F. ft.^{2}/BTU per inch, with factory applied all-service jacket with vapor barrier, butt and lap end strips shall be self-sealing or secured with vapor seal adhesive.

Fittings, Valves and Flanges: 2 inch size and smaller shall be insulated with 1 pound density and secured with 20 gauge annealed steel wire. Then apply insulating and finish cement to match the adjacent pipe insulation thickness and then have two (2) 1/8 inch thick smoothing and finishing coats of vapor seal adhesive applied using intermediate glass fabric reinforcing. Vapor seal adhesive shall lap adjacent pipe cover. Fittings may be insulated with two layers of fiberglass with PVC covers.

Valves, Fittings and Flanges: 2½ inch size and larger shall be insulated using sections of high density fiberglass molded sectional pipe insulation cut to fit, secured with 20 gauge annealed steel wire. All voids and pockets shall then be filled with

insulating cement and finish cement. Finish shall be two 1/8 inch thick smoothing and finishing coats of vapor seal adhesive applied using intermediate glass fabric reinforcing. Vapor seal adhesive shall alp adjacent pipe cover.

Class 107
Tubing and Piping: Insulation shall consist of flexible type foamed plastic pipe insulation with flame spread rating of 25 or less and smoke development rating of 50 or less per ASTM E84-75 test, integral vapor barrier. Insulation shall be slit type, field sealed with companion adhesive.

Fittings, Valves and Flanges: Tubing Systems – Fittings shall be made by miter cutting of adjacent straight piping runs and sealing joints with companion adhesive. Valves shall be insulated by using a combination of nested pipe insulation and sheets to form a complete enclosure with all joints sealed with companion adhesive. Flanges shall be insulated by using sheets cut to fit pipe side of flange and wrapping sheets around flange perimeter. All joints shall be sealed using companion adhesive. Piping Systems – Fittings shall be insulated using nested sections of pipe insulation mitered to form a square corner and sealing joints with companion adhesive. Valves and flanges shall be insulated as described for tubing systems.

D. PVC Piping Insulation Cover:

1. Piping insulation cover shall be of nominal thirty (30) mil UV stabilized PVC preformed to appropriate shapes for straight piping, fittings, valves and accessories. Solvent welding type adhesive shall form a permanent chemical bond between surfaces and shall present a continuous vapor barrier across the joint. PVC piping insulation cover shall incorporate the following characteristics.

Typical Properties	**Test Method**	**Value**
Service Range	N.A.	0°F. to 150°F
Specific Gravity	ASTM D-792	1.48
Flame Spread	ASTM E-84-97a	25
Smoke Developed	ASTM E-84-97a	50

Typical Properties	**Test Method**	**Value**
Flexural Strength	ASTM D-638	11,500 psi
Tensile Modulus	ASTM D-638	470,000 psi
Elongation at Yield	ASTM D-638	3% MD
Flexural Modulus	ASTM E-790	460,000 psi
Electrical Conductance	D-257	Non-conductor
Gardner-SPI Impact	D-3679	8 lb/mil (30 mil sample)
Abrasion	Taber Method	10,000 revolutions, CS-17 wheel, 1,000 gr weight
Water Vapor Transmission	ASTM E96-95	0.009 perms

2.27 INSULATION (SHEET METAL)

A. Sheet metal work shall be insulated as specified herein and as indicated on the drawings.

B. Insulation shall be applied to the following:
   1. All air conditioning systems ductwork and associated equipment exposed to view; all systems outside air plenums, ducts and louver boxes; all system exhaust air plenums, ducts and louver boxes from louver connections back to automatic dampers. All portions of heating and ventilating and air conditioning unit casings not internally insulated, all air conditioning systems return air fans and all equipment shall have Class 131 insulation.
   2. All concealed air conditioning system supply and return air ductwork and associated equipment including terminal box reheat coil casings, shall have Class 135 insulation.
   3. Insulation liner shall be provided where indicated on the drawings. Refer to sheet metal work.
   4. All sound attenuators in insulated system ductwork shall be insulated. Sound attenuator sections furnished with Rooftop air handling units shall be insulated in field when not furnished insulated by the unit manufacturer.

C. Kitchen grease ductwork shall have 3 inch Class 130 insulation.

D. Insulation shall be omitted from the following sheet metal work:
   1. Toilet, locker and storage exhaust ductwork except where noted on drawings.

E. All louver plenums, louver blank-off plates and ductwork which will conduct air shall have insulation thickness increased to a minimum of 2 inches or as indicated on drawings.

F. All supply and return ductwork located outside shall have rigid board insulation with thickness increased to a minimum of 3 inches and be provided with a weatherproof cover in addition to the vapor barrier.
   1. <u>Class 130</u>

      a. Insulation shall consist of a UL listed duct wrap system complying with UL 1978 and ASTM E-119. Blanket material shall be in alumina (45% ±) composite incorporating the following characteristics.
      b. Service Range: 0°F to 2300°F
      c. Melting Point: 3200°F
      d. R Value @ 70°F: $4.5\frac{Hr.Sq.Ft.°F.Inch}{BTU}$
      e. R Value @ 283°F: $9.9\frac{Hr.Sq.Ft.°F.Inch}{BTU}$
      f. Flame Spread: 5 (ASTM E84/UL-723)
      g. Smoke Developed: 5 (ASTM E84/UL-723)
      h. The blanket shall have a foil facing, adhered to the blanket mat, incorporating the following characteristics:
      i. Tensile Strength: M.D. 40#/IN (ASTM D-828)
         C.D. 40#/IN (ASTM D-828)
      j. Puncture Resistance: 100 Units (Min) (ASTM D-781)
      k. Self adhesive filament tape shall be of the high performance type equal to 3M Company *898.

l. Banding material, 3/4" wide, minimum 0.015" thick, carbon steel for construction requirements of zero clearance to combustibles or 1 hour ratings. Stainless steel banding shall be used for 2 hour requirements (SS wire ties or 1/4" SS hose clamps may be substituted for hanger insulation only).

m. Tensioning tool for banding material manufactured by Okle or by Signoide Company; seals such as those manufactured by Okle or by Signode Company; and crimping tool such as those manufactured by Okle or Signode.

n. 10 gauge, 4" to 5" long, copper coated steel pins; 1½" x 1½" galvanized steel speed clips; capacitor discharge stud gun (110/115) such as that manufactured by AGM.

o. Grease duct access door hardware; 4½" x 5" long, 1/4" wing nuts and 1/4" metal washers; 4" long steel hollow tubing to fit threaded rods.

2. Class 131

a. Insulation shall consist of 1½ inch thick minimum 4 pound density rigid fiberglass board with reinforced foil vapor barrier cut to fit duct shape and applied by impaling insulation on pins attached to duct surface. Pins shall be located approximately 1 per square foot of surface. Insulation shall be secured on pins using metal washers with excess pin length trimmed. Seal seams and all vapor barrier penetrations using 4 inch wide reinforced foil tape self-sealing type or secured using vapor seal adhesive.

b. Note: Flanges protruding from sheet metal shall be covered with 4 inch wide insulation board strips and sealed with 4 inch wide reinforced tape secured with vapor seal adhesive.

c. Finish shall consist of pre-sized glass fabric jacket applied to insulation surface and secured with lagging adhesive. All plenums and ducts within 5 feet of floors shall have edges reinforced with metal corner beads applied to insulation and sealed with 4 inch reinforced foil tape secured with vapor seal adhesive prior to finish.

3. Class 135

a. Insulation shall consist of minimum 1½ inch thick flexible fiberglass blanket with reinforced foil vapor barrier. Insulation shall be tightly wrapped around duct and secured using bonding adhesive covering not less than 50 percent of sheet metal surface. Seams and penetrations shall be sealed by using 4 inch wide reinforced foil tape self-sealing type or secured with vapor seal adhesive. The bottom of ducts over 24 inches wide shall have additional support for blanket consisting of pins attached to duct surface at a rate of 1 per 2 square feet, evenly spaced. Insulation shall be impaled on pins and secured using mechanical washers with excess pin length trimmed.

G. Ductwork Weatherproof Insulation Cover:

1. Weatherproof insulation cover shall be a self-adhering roll-type roofing membrane consisting of a laminated assembly of aluminum facing, two (2) layers of styrene-buadiene-styrene and a nominal forty (40) mil layer of rubberized asphalt adhesive. Asphalt adhesive compound shall be pressure sensitive, protected by a release paper u ntil installation. Composite assembly shall incorporate the following characteristics.

Typical Properties	**Test Method**	**Value**
Service Range	N.A.	-25°F. to 150°F.
Heat Aging	ASTM D-794	No visible blistering, de-lamination or deterioration
Flame Spread	ASTM E-84-97a	0 (NFPA Class "A")
Smoke Density	ASTM E-84-97a	5
Tear Strength	ASTM D-1424	680 gr MD 640 gr CD
Tensile Strength	ASTM D-1000	500 p si MD 625 psi CD
Elongation	ASTM D-1000	296% MD 228% CD
Static Uplift	ASTM E-907	No damage or failure evident @ 75 psf for 1 minute
Wind Driven Rain	South Florida Test 5683	No leakage, damage or failures evident @ 100 MPH
Lap Joint Tensile Strength	MFM Method	Exceeds material strength
Lap Joint Peel Strength	MFM Method	11 lb/in (180° angle)
Abrasion	Taber Method	10,000 revolutions, CS-17 wheel, 1,000 gr weight
Low Temperature Flexibility	MFM Method	100,000 cycles @ 10°F with no cracking
Q-U-C Accelerated Weathering	Q Panel Co. UV Chamber per Rubber Manufacturer's Association	4,000 hr exposure surface and lap joints, no effect
Reflectivity	Photo-volt meter	129 (black surface ≈ 29)
Water Vapor Transmission	ASTM E96-95	0.009 perms

2.28 MAKE-UP AIR UNIT (INDIRECT GAS FIRED)

A. Provide factory fabricated H&V units in the sizes and capacities as identified on the drawings. Units shall be indirect fired by natural gas, shall draw combustion air in through a dedicated vent and shall discharge products of combustion through a dedicated vent. Units shall be as manufactured by Reznor, Greenheck or Sterling.

B. Equipment casings shall be sectional type factory assembled of indicated manufacturer's standard design for system static pressures. Casings shall be provided with galvanized or baked enamel corrosion resisting finish. Individual sections shall be bolted together utilizing gaskets and then mastic sealed. All sections shall have 1 inch thick fiberglass lining secured using adhesive and provided with air side air erosion coating. Provide access doors to all fan sections and furnace sections.

C. Units shall be mounted from four point lifting and anchor holes suitable for suspension mounting, in accordance with manufacturer's instructions.

D. Mixing shall occur directly within the blower section. Mixing system shall have parallel bladed return and outside air dampers with active sections sized to produce 1,200 FPM to 1500 FPM through either section at design air flow. Where excessive damper blades are provided, blank off the furthest blade. Dampered openings shall be arranged at right angles to one another with two (2) sets of parallel blades forcing the two air streams together. Outside air dampers shall be gasketed.

E. Filter sections shall be field fabricated as separate sections as indicated on the drawings. Filters shall be low velocity type except as indicated otherwise on the drawings and shall be 4 inch MERV 13 type. Filter shall be mounted in metal holding frames accessible from either side of the casing. Provide three (3) spare sets of filters.

F. Heat exchanger(s) construction shall consist of 20 gauge (minimum), Type 409 stainless steel tubes, seams electric resistance welded, with 20 gauge (minimum) Type 409 stainless steel headers.

G. Burners shall be die-formed with stamped porting and stainless steel port protectors to prevent scale or foreign matter from obstructing the burner ports. Burner construction shall consist of Type 409 stainless steel, seams electric resistance welded.
   1. Burners must be individually removable for cleaning and servicing. The entire burner assembly must be easily removable with a slide-out drawer design. The pilot must be accessible through a pilot access plate without removing the burner assembly.

H. Venting shall occur through a power type separated combustion system as identified on the drawings.
   1. Flue collector construction shall consist of Type 409 stainless steel, seams electric resistance welded.
   2. Air for combustion shall be entrained through a dedicated combustion air inlet vent by an integral vent fan designed for the furnace size it serves. Vent shall terminate through a factory fabricated intake. Combustion air shall be precisely metered in accord with the required firing rate to produce appropriate fuel-air combinations for optimum combustion efficiency.
   3. Products of combustion shall be discharged through a dedicated flue gases vent. Vent shall terminate through a factory fabricated exhaust terminal a minimum of twenty-four inches (24") above the nearest construction within a ten foot (10'0") radius and a minimum of eighteen inches (18") above the combustion air inlet.
   4. Combustion air inlet vent and flue gases vent shall run independently from the furnace to a factory fabricated concentric adapter. The adapter shall form the combustion air inlet vent into a concentric sleeve around the flue gases vent. The two concentrically oriented vents shall run together to their respective coaxial terminations.

I. Units shall be provided with gas valves suitable for Class 2, maximum inlet pressure of 0.5 psig (14 inch wc) on natural gas. The low voltage combination automatic gas valves must include:

1. Main operating valve.
2. Pilot safety shut off.
3. Pressure regulator.
4. Manual main shut off valve.
5. Manual pilot shut off valve.
6. Adjustable pilot valve.
7. Gas valves shall be of the electronic type providing modulated heat output. Ignition shall be at full fire (100 percent input). The gas valve shall modulate from 100% rated input to 50% rated input.

J. The solid state ignition control system shall ignite the required pilot(s) by direct spark during each cycle of operation. When pilot flame(s) are proven, main burner valve(s) shall open to allow gas flow to the burners. Pilot(s) and burner(s) must be extinguished during the “Off” cycle.

K. Fan sections for low pressure service shall have forward curved fan wheels, except where specifically noted otherwise. All fan wheels shall be statically and dynamically balanced and so designed that the first critical speed is not less than 20 percent beyond the indicated operating space. Fan bearings shall be grease lubricated type with extended grease nipple. Fans shall have V-belt drives with motors mounted on adjustable slide bases. Motors shall have adjustable sheaves. V-belt drives shall have belt guards with hole at fan shaft for tachometer readings. Unit shall have rubber vibration isolator rails.

L. Supply fan motors shall open drip proof (ODP) design, premium efficiency, and inverter rated.
1. Motors shall be provided with internal thermal overload protection, external overload protection with heaters, or magnetic starters. Motors 1/2 horsepower and larger shall be suitable for poly-phase electric service.
2. Motor wiring shall be enclosed in 1/2 inch Greenfield cable.
3. Supply fan motors shall be activated through a magnetic starter.

M. A factory installed and wired single point power connection junction box shall feed a factory installed and wired control box including any necessary control service transformers, high limits, and fan delay relays. The fan delay relay shall delay the fan start until the heat exchanger reaches a pre-determined, factory set temperature. The fan delay relay shall require the fan to operate after burner shut-down to remove residual heat from the heat exchanger.

N. Factory installed options shall include:
1. 120 volt convenience outlet.
2. Firestat to shut unit down and notify all fire alarm functions if discharge air reaches a factory preset temperature. Firestat shall require manual reset.
3. Factory mounted and wired variable frequency drive with P.I.D. control.
4. Disconnect switch.

O. Field installed options shall include:
1. High gas service pressure regulator, to reduce the main gas line pressure from a maximum of 125 psig to a minimum of 5 inches water column.
2. One main set and two spare sets of filters.
3. Clogged filter switch shall sense the suction pressure increase incurred by the blower due to filter obstruction. Switch shall indicate in the blower compartment and shall incorporate normally-open contacts for remote notification.

4. Roof mounting curb for equipment scheduled for roof mounting.

P. Provide flexible braided stainless pipe connectors at least 12 inches long in each piping connection to the unit.

Q. Submittals shall show operating characteristics of each equipment section and note all operation data indicated on the drawings for the actual equipment selections. Also provide individual assembly drawings for Rooftop air handling unit showing sequence of sections and all accessories furnished as part of the equipment. Individual unit sound power levels shall be separately tabulated together with scheduled design limitations.

2.29 MOTORS

A. This section identifies basic requirements for motors. It includes motors that are factory-installed as part of equipment and appliances as well as field-installed motors.

B. Quality Assurance:
1. Comply with NFPA 70 “National Electrical Code”.
2. NRTL Listing: Provide NRTL listed motors.
   a. Term “Listed”: As defined in “National Electrical Code”, Article 100.
   b. Listing Agency Qualifications: “Nationally Recognized Testing Laboratory” (NRTL) as defined in OSHA Regulation 1910.7.
3. Comply with NEMA MG 1: “Motors and Generators”.
4. Comply with UL 1004: “Motors, Electric”.

C. All motors provided for this project shall comply with the requirements of this section, except as otherwise indicated.
1. Motors 1/2 HP and Larger: Polyphase
2. Motors Smaller than 1/2 HP: Single phase.
3. Frequency Rating: 60 Hz.
4. Voltage Rating: Determined by voltage of circuit to which motor is connected for the following motor voltage ratings (utilization voltages):
   a. 120V Circuit: 115 V – motor rating.
   b. 208V Circuit: 200 V – motor rating
   c. 240V Circuit: 230 V – motor rating.
   d. 480V Circuit: 460 V – motor rating.
5. Service factors indicated for motors are minimum values and apply at frequency and utilizing voltage at which motor is connected. Provide motors which will not operate in service factor range when supply voltage is within 10 percent of motor voltage rating.
6. Capacity: Sufficient to start and operate connected leads at designated speeds in indicated environment, and with indicated operating sequence, without exceeding nameplate ratings. Provide motors rated for continuous duty at 100 percent of rated capacity.
7. Temperature Rise: Based on 40 degree C. ambient except as otherwise indicated.
   a. Enclosure: Totally Enclosed Air Over

D. Polyphase Motors:
1. General: Squirrel-cage induction type conforming to the following requirements except as otherwise indicated.

a. NEMA Design Letter Designation: “A” or “B”

2. Multi-Speed Motors: Separate winding for each speed.
3. Premium Efficiency Motors: Nominal efficiency equal to or greater than that stated in NEMA Standard Publication MG 1-2003, Tables 12-12 and 12-13 respectively.
4. Variable speed motors for use with solid-state drives: Energy efficient, squirrel-cage induction, design B units with ratings, characteristics, and features coordinated with and approved by drive manufacturer.
5. Internal thermal overload protection for motors: For motors so indicated, protection automatically opens control circuit arranged for external connection. Protection operates when winding temperature exceeds safe value calibrated to the temperature rating of the motor insulation.
6. Bearings: Double-shielded, prelubricated ball bearings suitable for radial and thrust loading of the application.
7. Rugged Duty Motors: Totally enclosed with 1.25 minimum service factor. Provide motors with regreasable bearings and equipped with capped relief vents. Insulate windings with nonhygroscopic material. External finish shall be chemical resistant paint over corrosion resistant primer. Provide integral condensate drains.
8. Motors for reduced in-rush starting: Coordinate with indicated reduced in-rush controller type and with characteristics of driven equipment load. Provide required wiring leads in motor terminal box to suit control method.

E. Single-Phase Motors:

1. General: Conform to the following requirements except as otherwise indicated.
2. Energy Efficient Motors: One of the following types as selected to suit the starting torque and other requirements of the specific motor application:
   a. Permanent Split Capacitor
   b. Split-Phase Start, Capacitor-Run
   c. Capacitor-Start, Capacitor-Run
3. Shaded-Pole Motors: Use only for motors smaller than 1/20 HP.
4. Internal Thermal Overload Protection for Motors: For motors so indicated, protection automatically opens the power supply circuit to the motor, or a control circuit arranged for external connection. Protection operates when winding temperature exceeds a safe value calibrated to the temperature rating of the motor insulation. Provide device that automatically resets when motor temperature returns to normal range except as otherwise indicated.
5. Bearings, belt connected motors and other motors with high radial forces on motor shaft shall be ball bearing type. Sealed, prelubricated sleeve bearings may be used for other single phase motors.

2.30 PIPE, HANGERS, SUPPORTS AND ANCHORS

A. Provide all necessary labor, supervision, materials, equipment and services required to furnish and install all pipe supports, hangers, anchors and other suitable supporting appliances necessary to support firmly and substantially all parts of the apparatus described in this specification. Equipment shall be as manufactured by B-Line, Uni-Strut, Grinnell or Carpenter & Patterson.

1. Pipe shall be adequately supported by pipe hanger and supports and restrained by anchors. Hangers for insulated pipes shall be sized to accommodate insulation thickness.

B. Steel pipe hangers, anchors and supports shall have the manufacturer's name, part number, and applicable size stamped into each part for identification.

C. Hangers, anchors and supports shall be designed and manufactured in conformance with the following standards as appropriate.
   1. ASTM B633: Specification for Electro-deposited Coatings of Zinc on Iron and Steel.

   2. ASTM A123: Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars and Strip
   3. ASTM A653 G90: Manufacturers Standardization Society: Pipe Hangers and Supports – Materials, Design and Manufacture
   4. MSS SP69: Manufacturers Standardization Society: Pipe Hangers and Supports – Selection and Application

D. Hangers:
   1. Uninsulated pipes 2 inches and smaller:
      a. Adjustable steel swivel ring (band type) hanger.
      b. Adjustable steel swivel J-hanger.
      c. Malleable iron ring hanger or hinged ring hanger.
      d. Malleable iron split-ring hanger with eye socket.
      e. Adjustable steel clevis hanger.
   2. Uninsulated pipes 2½ inches and larger.
      a. Adjustable steel clevis hanger.
      b. Pipe roll with sockets.
      c. Adjustable steel yoke pipe roll.
   3. Insulated Pipe – Hot Services (including steam piping):
      a. 2 Inch and Smaller Pipes:
         1) Adjustable steel clevis with galvanized sheet metal shield.
      b. 2½ Inch and Larger Pipes:
         1) Adjustable steel yoke pipe roll with pipe covering protection.
         2) Pipe roll with sockets with pipe covering protection saddle.
   4. Insulated Pipe – Cold Services (including chilled water piping):
      a. 5 Inch and Smaller Pipes:
         1) Adjustable steel clevis with galvanized sheet metal shield.
      b. 6 Inch and Larger Pipes:
         1) Pipe roll with sockets with pipe covering protection saddle.
         2) Adjustable steel yoke pipe roll with pipe covering protection.

E. Pipe Anchors:
   1. Provide a complete system of accessories to transmit thermal expansion forces to the building structure for redirection to the piping expansion compensation system. Anchors shall consist of structural attachments, framing members for translating forces to and from the building structure and plates welded to the appropriate piping sections.
   2. Structural attachments shall be as appropriate for the point of connection intended. Verify anchor connection points with Project Structural Engineer prior to fabrication.

3. Framing members shall be sized to accept the forces associated with the Contractor's proposed piping system arrangement with a minimum factor of safety of 3.0.
4. Framing point of attachment to the appropriate piping section shall be of a minimum thickness of 1/4" and shall increase by 1/16" in thickness for each two-pipe size increases above three inches in diameter (3"Φ). Framing point of attachment to the appropriate piping section shall be of a minimum length of 16" and shall increase by 2" in length for each two pipe size increases above three inches in diameter (3" Φ).
5. Welds to connect framing point of attachment to the appropriate piping section shall be full penetration fillet welds parallel to the central axis of the piping. All welding processes, including but not limited to procedures and welding operator qualifications, shall be in strict accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code (edition, including any addenda, in effect at the time of the contract execution).

F. Pipe Clamps:
1. Provide pipe clamps with weld-less eye nuts to allow flexibility in the hanger assembly to adjust for horizontal movement. Provide double bolted pipe clamps for insulated lines.

G. Multiple or Trapeze Hangers:
1. Trapeze hangers shall be constructed from 12 gauge roll formed ASTM A570 Gr. 33 structural steel channel, 1⅝ x 1⅝" minimum, or stronger.
2. Mount pipes to trapeze with 2 piece pipe straps sized for outside diameter of pipe.
3. For pipes subjected to axial movement:
   a. Strut mounted roller support. Use pipe protection shield or saddles on insulated lines.
   b. Strut mounted pipe guide.

H. Wall Supports:
1. Pipes 4 Inches and Smaller:
   a. Carbon steel hook.
   b. Carbon steel J-hanger.
2. Pipes Larger than 4 Inch:
   a. Welded strut bracket and pipe straps.
   b. Welded steel brackets, with roller chair or adjustable steel yoke pipe roll. Use pipe protection shield or saddles on insulated lines.

I. Floor Supports:
1. In mechanical spaces where weight of piping or other apparatus makes it impractical to support same suspended only from structure above, flanged pipe standards shall be installed to support the weight of the piping, valves and fittings. Main passageways and access space must not be obstructed.
2. Hot piping under 6 inch and all cold piping:
   a. Carbon steel adjustable pipe saddle and nipple attached to steel base stand sized for pipe elevation. Pipe saddle shall be screwed or welded to appropriate base stand.
3. Hot piping 6 inches and larger:
   a. Adjustable roller stand with base plate.

b. Adjustable roller support and steel support sized for elevation.

J. Vertical Supports:
1. Steel riser clamp sized to fit outside diameter of pipe.

K. Copper Tubing Supports:
1. Hangers shall be sized to fit copper tubing outside diameters.
   a. Adjustable steel swivel ring (band type) hanger.
   b. Malleable iron ring hanger, or hinged ring hanger.
   c. Malleable iron split-ring hanger with eye socket.
   d. Adjustable steel clevis hanger.
2. For supporting vertical runs use epoxy painted or plastic coated riser clamps.
3. For supporting copper tube to strut use epoxy painted pipe straps sized for copper tubing, or plastic inserted vibration isolation clamps.

   Note: Copper plating of hangers is for purposes of identification only. This superficial coating shall not be designed to provide significant protection in corrosive areas.

L. Plastic Pipe Supports:
1. V-bottom clevis hanger with galvanized 18 gauge continuous support channel.

M. Supplementary Structural Supports:
1. Design and fabricate supports using structural quality steel bolted framing materials as manufactured by B-Line or Uni-Strut.
2. Channels shall be roll formed, 12 gauge, ASTM A570 Grade 33 steel, 1⅝" x 1⅝" or greater as required by loading conditions. Submit designs for pipe tunnels and pipe galleries to Engineer for approval.
3. Clamps and fittings shall be specifically designed and listed for use with the strut system.

N. Upper Attachments:
1. Beam clamps shall be used where piping is to be suspended from building steel. Clamp type shall be selected on the basis of load to be supported, and load configuration.
   a. C-Clamps shall have locknuts and cup point set screws. Top flange c-clamps shall be used when attaching a hanger rod to the top flange of structural shapes. Refer to manufacturer's recommendations for setscrew torque. Retaining straps shall be used to maintain the position on the beam where required.
   b. Center loaded beam clamps shall be used where specified. Steel clamps, malleable iron or forged steel beam clamps with cross bolt shall fit beams.
2. Concrete Inserts:
   a. Cast in place spot concrete inserts shall be used where applicable, either steel or malleable iron body. Spot inserts shall allow for lateral adjustment and have means for attachment to forms. Select inserts to suit threaded hanger rod sizes.
      1) Arrange pipe hangers, and auxiliary framing if required, to limit the maximum pipe load, with pipes fully insulated and

filled with water, to not exceed 1500 pounds on any one slab insert.

2) Inserts shall be spaced not closer than 4 feet o.c. in either direction. Where pipe inserts are closer together than 4 feet o.c. notify the Architect for review.

b. Continuous concrete inserts shall be used where applicable. Channels shall be 12 gauge, ASTM A570 Grade 33 structural quality carbon steel, complete with Styrofoam inserts and end caps with nail holes for attachment to forms. The continuous concrete insert shall have a minimum load rating of 2,000 lbs/ft. in concrete. Select channel nuts suitable for strut and rod sizes.

c. Provide inserts for placement in form-work before concrete is poured.

d. Provide inserts for suspending hangers from reinforced concrete slabs and sizes of reinforced concrete beams.

e. Where concrete slabs form finished ceilings, provide inserts to be flush with slab surface.

f. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

O. Vibration Isolation and Supports:

1. Refer to Section “Vibration Isolation and Seismic Restraints” for vibration isolation requirements.
2. All horizontal runs of pipe in all mechanical equipment rooms, and for a distance of fifty (50) equivalent pipe diameters beyond the respective mechanical equipment rooms, shall be isolated from building structure by means of units designed for insertion of rids. Selection of correct isolators for each application shall be made by the vibration isolation manufacturer subject to approval of the Architect.

P. Accessories:

1. Hanger rods shall be threaded both ends, or continuous threaded rods of circular cross section. Use adjusting locknuts at upper attachments and hangers. No wire, chain or perforated straps shall be allowed.
2. Shields shall be 180° galvanized sheet metal, 12” minimum length, 18 gauge minimum thickness, designed to match outside diameter of the insulated pipe.
3. Pipe protection saddles shall be formed from carbon steel, 1/8 inch minimum thickness, sized for insulation thickness. Saddles for pipe sizes greater than 12 inches shall have a center support rib.

Q. Finishes:

1. Hangers not in direct contact with copper pipe shall be zinc plated in accordance with ASTM B633, SC3 or have an electro-deposited epoxy finish.
2. Strut channels shall be pre-galvanized in accordance with ASTM A653 G90 or Strut channels shall be electro-deposited epoxy finish.
3. Hangers and strut located outdoors shall be hot dip galvanized after fabrication in accordance with ASTM A123.
4. Hangers and strut located in corrosive areas shall be Type 316 stainless steel with matching stainless steel hardware.

5. Hangers and clamps for support of bare copper piping shall be painted with electro deposited copper colored epoxy.

R. Support Spacing:

1. Horizontal steel piping shall be supported in accordance with MSS SP-69 Tables 3 and 4, excerpts of which follow below:

NOMINAL PIPE SIZE	ROD DIAMETERS	MAX. SPACING
1/2” - 1½”	3/8”	7’0’
1½”	3/8”	9’0”
2”	3/8”	10’0”
2½”	1/2”	11’0”
3”	1/2”	12’0”
4”	5/8”	14’0”

2. Horizontal copper tubing shall be supported in accordance with MSS SP-69 Tables 3 and 4, excerpts of which follow below:

NOMINAL TUBE SIZE	ROD DIAMETERS	MAX. SPACING
1/2” – 3/4”	3/8”	5’0’
1”	3/8”	6’0”
1¼”	3/8”	7’0”
1½”	3/8”	8’0”
2”	3/8”	9’0”
2½”	1/2”	10’0”
3”	1/2”	11’0”
4”	1/2”	12’0”

S. Provide means of preventing dissimilar metal contact such as plastic coated hangers, copper colored epoxy paint, or non-adhesive isolation tape. Galvanized felt isolators sized for copper tubing may also be used.

T. Install hangers to provide a minimum 1/2 inch space between finished covering and adjacent work.

U. Place a hanger within 12 inches of each horizontal elbow.

V. Support vertical piping independently of connected horizontal piping. Support vertical pipes at every other floor. Wherever possible, locate riser clamps directly below pipe couplings or shear lugs.

W. Where several pipes can be installed in parallel and at the same elevation, provide trapeze hangers as specified herein above. Trapeze hangers shall be spaced according to the smallest pipe size, or install intermediate supports according to schedule herein above.

X. Do not support piping from other pipes, ductwork or other equipment which is not building structure.

2.31 PIPING MATERIALS

A. All piping materials installed under this section shall be new and shall consist of the following materials of construction:

System of Section	Piping Class
Hot Water Supply and Returns	2
Chilled Water Supply and Returns	2
Make-Up Water	20
Relief Valve and Vent Lines	2
Drain Lines	2
Cooling Coil and Louver Condensate Pan Drains	20
Chemical Feed	9
Refrigerant Piping	12

Note: Class 20 piping may be used in lieu of Class 2 piping for two-inch (2”) and smaller diameter piping for hot water, chilled water and any size drain line.

B. Class 2 Piping System

	2 Inches and Smaller	2-1/2 Inches and Larger
Construction	Screwed construction with screwed or flanged connections to equipment.	Butt-welded construction with flanged connections to valves and equipment.
Piping	Carbon steel, Schedule 40, ANSI B36.10, ASTM A120.	Carbon steel, Schedule 40 to 8"; Schedule 30 for 10" to 18"' Schedule 20 for 20" to 24"; ANSI B36.10, ASTM A53, Grade A or B (except that all steam and hydronic heating systems piping shall be Schedule 40).
Fittings	Malleable iron, 150 lb. class screwed ends, ANSI B16.3, ASTM A197.	Carbon steel, schedule to match piping, butt-weld ends, ANSI B16.9, ASTM A234, Grade WPA.
Couplings	Same as "Fittings" above.	
Unions	Malleable iron, 300 lb. class, screwed ends, ANSI bronze-to-bronze type, ANSI B16.5, ASTM A181, Grade 1.	Forged steel, 150 lb. ANSI Standard weld-neck type flange, ANSI B16.5, ASTM A181, Grade 1.
Flanges	Forged steel, 150 lb. ANSI standard screw-on type, ANSI B16.5, ASTM A181, Grade 1.	Same as "Unions" above.

C. Class 9 Piping System

	2 Inches and Smaller	2-1/2 Inches and Larger
Construction	Screwed construction with screwed or flanged connections to equipment.	Butt-welded construction with flanged connections to valves and equipment.
Piping	Stainless steel, Schedule 40, ANSI B36.26, ASTM A312, Grade TP 304L.	Stainless steel, Schedule 40, ANSI B36.26, ASTM A312, Grade 304L.
Fittings	Forged stainless steel, 2000 lb. ANSI standard, screwed type, ANSI B16.11, ASTM A182, Grade F304.	Forged stainless steel, Schedule 40, butt-welded ends, ANSI B16.9, ASTM A182, Type 304L.
Couplings	Same as "Fittings" above.	
Unions	Forged stainless steel, 2000 lb. ANSI standard, socket-welded stainless steel seats, ASTM A182, Grade F304.	Forged stainless steel, 300 lb. ANSI standard, weld-neck type flange, ASTM A182, Grade F304.
Flanges	Forged stainless steel, 300 lb. ANSI standard, socket-welded type, ASTM A182, Grade F304.	Same as "Unions" above.

D. Class 12 Piping System

	All Pipe Sizes
Construction	Hard brazed joints.
Piping	Copper tubing, Type ACR, hard drawn; cleaned, dehydrated and capped for refrigeration service, ANSI B70.1, ASTM A280.
	All Pipe Sizes
Fittings	Wrought copper, brazed joint type, ANSI B16.22.
Couplings	Same as "Fittings" above.
Brazing Alloy	East Flo, Sil Fos, Phos. Co. minimum 1100 ºF melting temperature ASTM B260.

E. Class 20 Piping System

	2 Inches and Smaller	2-1/2 Inches to 8 Inches
Construction	Soldered joint construction with threaded adaptors.	Screwed construction with flanged connections to valves and equipment.
Piping	Copper, Type L, hard drawn, ANSI H23.1, ASTM B88.	Carbon steel (galvanized), Schedule 40, ANSI B36.20, ASTM A120.
Fittings	Cast bronze or wrought copper, solder joint type, ANSI B16.19 or B16.22.	Cast iron (galvanized), 125 lb. class, screwed ends, ANSI B16.3, ASTM A197.
Couplings	Same as "Fittings" above.	Same as "Fittings" above.
Unions	Wrought copper, solder joint type, ANSI B16.19 or B16.22.	Malleable iron fittings (galvanized), 125 lb. ANSI standard, screw-on type, ANSI B16.1.

F. Flange Bolts and Nuts
1. CI to CI, CI to CS, CI to CB and CB to CB.
2. Bolts: ANSI, B181, ASTM A307, Grade B, square head, coarse threaded series, Class 2B fit.
   a. CS to CS
   b. Stud Bolts: ASTM A193, Grade B7, Class 2A fit.
   c. Nuts: ANSI B18.2.2, ASTM A194, Grade B7, heavy hexagonal series, semi-finished, Class 2B fit.

G. Gaskets: For all pipe classes except as note:
1. Gaskets: Flat ring 1/16-inch thick rubber, Garlock Style 3100 graphite or equal. ADA rated for service.
2. For make-up water service and cooling tower water.
   a. Gaskets: Full face 1/16-inch thick rubber, Garlock 22 or equal.
   b. For fuel oil service:
      1) Gaskets - Garlock 2021.

H. Solder for Class 20 Piping: 95-5 tin antimony or 95.5 lead-tin conforming to ASTM B32, allow Grade 5A.

I. Pre-insulated Piping – Underground Chilled Water System:

1. Provide pre-insulated piping by Interpipe Insulation, LLC for underground chilled water supply and return service complete with high density polyethylene (HDPE) outer casing, polyurethane foam insulation, and steel carrier pipe. Carrier pipes shall be pre-insulated in maximum single or double-random lengths without fittings and having a minimum of 6-inches of exposed carrier pipe ready for field welding to adjacent pipe and or fitting units.

2. Provide product data submittals for approval. After approval of submittals and before release of any materials for fabrication, the installing contractor shall furnish to the manufacturer a completed field verified survey of the proposed piping layout. The survey shall show all layout dimensions and angles of bends required for fabrication of the system.

3. Provide steel carrier pipe with field-welded joints. Carrier pipe shall be Schedule 40, ASTM A53, Grade B, ERW.

4. Provide factory foamed-in-place polyurethane foam insulation with the following minimum characteristics.

K-factor:	0.130
Density:	2.0 pounds per cubic foot
Closed Cell Content:	90-95% in conformance with MIL-I-24172 & ASTM C-591

Insulation shall completely fill the annular space between the carrier pipe and outer jacket. Minimum insulation thickness shall be as follows:

Pipe Size & Service	Insulation Thickness (min.)	Jacket Size (Min. O.D.)	Jacket Wall Thick. (min.)
6” CHWS & R	1.51”	10.00”	0.175”
8” CHWS & R	1.72”	12.43”	0.175”

5. Provide outer jackets of seamless extruded black high-density polyethylene (HDPE) having a minimum wall thickness of 0.175”. Jacketing comprised of counter wound or overlapping layers of polyethylene, and jackets having less than the minimum wall thickness specified shall not be acceptable. The polyethylene shall be manufactured from polyethylene resin compound qualified as Type III, Category 5, Class C, Grade P23 or P34 in accordance with ASTM D1248 and D3350.

6. Provide with each length of pre-insulated pipe and exposed ends of fittings watertight mastic end seal at jacket and pipe surfaces. All exposed field cuts will be sealed with a field applied mastic end seal with materials supplied by the manufacturer.

7. Provide prefabricated and pre-insulated fittings having the same material and physical characteristics as for the straight pipe sections. Fittings shall be furnished with the manufacturer’s standard tangent lengths and having 6-inches of exposed carrier pipe ready for field welding to straight sections. Field fabricated and insulated fittings shall not be acceptable.

8. Provide a 4-inch layer of sand, placed and tamped in the trench to provide uniform bedding for the system. The entire trench shall be evenly backfilled with a similar material as the bedding in 6-inch compacted layers to a minimum height of 6-inches above the top of the insulated piping system. The remaining trench shall be evenly and continuously backfilled in uniform layers with suitable excavated soil free of any organic material, frozen soil and rocks over 3-inches in size.

9. Provide joint insulation and closure materials as factory supplied assemblies consisting of pre-formed urethane foam insulation half-shells, HDPE sleeves, and heat-shrinkable wrap-around sleeve closures. The installing contractor shall field install joint closures after successful completion of all testing.

10. Perform a hydrostatic test of the carrier pipes at 1.5 system operating pressure or 150-psig, whichever is greater, for a period of not less than 4 hours. If a leak occurs it shall be repaired and the test repeated. After approved by test, all field joints shall be insulated and covered by the contractor, with materials furnished by the manufacturer.

2.32 REFRIGERANT PIPING AND SPECIALTIES

A. Summary:
1. Extent of refrigeration piping, fittings, valves and accessories is indicated (on the drawings and by the requirements of this section and section 15B.03 “General Requirements – Mechanical”).
   a. Refrigeration piping is specified on a performance basis and the Contractor is responsible for the design and preparation of shop drawings covering all refrigeration piping work.
2. Related Sections: Refer to other Division 15 sections for the following:
   a. Mechanical Insulation

B. Quality Assurance:
1. Codes and Standards: Provide refrigeration piping conforming to the requirements of the following:
   a. Air Conditioning and Refrigeration Institute (ARI).
   b. American National Standards Institute (ANSI).
   c. American Society for Testing and Materials (ASTM).
   d. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
   e. Manufacturer’s Standardization Society of the Valve and Fittings Industry, Inc. (MSS).

C. Submittal:
1. Refer to Section 15B.02, “Submittals” for basic information relating to submittal requirements.
2. Product Data: Submit manufacturer’s technical product data on the following:
   a. Refrigerant Valves
   b. Refrigerant Specialties

D. Refrigerant Piping:
1. Refrigerant Piping: Dimensions and material requirements for pipe, pipe fittings and components shall conform to ASHRAE 15 and ANSI B31.5 and shall be compatible with fluids used and capable of withstanding the pressures and temperatures of the service.
   a. Tubing used for refrigerant service shall be cleaned, sealed, capped, or plugged prior to shipment from the manufacturer’s plant.

2. Composite Pipe Option
   a. At contractor's option the use of "Multi -Flex Pipe" may be used for pipe up to 1-1/8" and units up to 5 tons. It shall be capable of a temperature range from -40*F-220*F and a working pressure of 650psi.
   b. Pipe must carry the following approval: ICC-ES LC 1035-2013 report PMG-1221.
   c. Pipe must be in Compliance with the following codes:

      2015- (IMC) International Mechanical Code
      2015- (IRC) International Residential Code
      2012- (UMC) Uniform Mechanical Code
   d. Pipe shall carry a 25 year warranty against defects in material and workmanship." Multi-Flex Pipe" is represented by Green Technology Associates of Hingham, MA.

E. Valves and Accessories:
   1. Valves: Provide valves designed, manufactured and tested specifically for refrigerant service.
      a. Internal parts shall be removable for inspection or replacement without applying heat or breaking pipe connections. Threaded ends of valves shall conform to ANSI B2.1.

F. Execution – General:
   1. Installation: Install piping components to ensure proper and efficient operation of the equipment and controls and in accordance with manufacturer's printed instructions.
      a. Provide proper supports for the mounting of vibration isolators, stands, guides, anchors, clamps and brackets.
      b. Provide piping connected to equipment with vibration isolators with flexible connections which shall conform to vibration and sound isolation requirements for the system.
      c. Conform to ASHRAE 15 and ANSI B31.5.

2.33 PRESSURE GAUGES

A. Pressure gauges shall be of sizes, types and capacities specified herein and located as indicated on the drawings. Equipment shall be as manufactured by Ashcroft, Trerice or Manning, Maxwell, Maxwell and Moore.

B. Except as otherwise indicated, all gauges shall be 4½ inch diameter stainless steel case and ring phosphor bronze bourbon type, 1 percent full scale accuracy and bottom connection. Gauges for panel mounting shall have stainless steel flush mounting ring and back connection. Gauges for fluid handling service shall have isolating cock and also fitting with pulsation dampeners and red setpoint indicators at pump inlets and outlets. Gauges for steam service shall have coil syphon and isolating cock. All cocks shall be rated at 150 WSP except on HP steam service, 250 WSP.

C. Gauge range shall be as follows:

   1. Chilled Water 0-100 PSIG
   2. Hot Water 0-100 PSIG

Note: Mount all gauges so as to be read from floor. Provide two (2) spare gauges for each range indicated.

2.34 PUMPS

A. Pumps shall be of sizes, types, capacities and arrangements indicated on Drawings. Equipment shall be manufactured by Taco, Bell and Gossett, Grundfos or Armstrong.

B. Equipment shall be complete shop-assembled packages with pump, motor drive couplings, pump base assemblies and accessories. All equipment shall be shop primed and finish painted. All pumps shall be field checked for alignment and corrected prior to start-up. This Contractor shall be responsible for insuring compatibility of chemical treatment program with pump seals used. Pumps shall not overload their drivers along any point of their entire operating curves. All pumps shall have suction and discharge flanges drilled and tapped for pressure gauge installation. All pumps shall be capable of operating at water temperatures from 35 degrees F. to 250 degrees F. All pumps shall have drip bases. Drip bases to be piped to floor drain and shaft seal drains shall be piped to drip base by this Contractor.

C. Inline Suction Pumps: Pumps shall be base mounted, single stage, double suction design with a foot mounted volute to allow servicing of the impeller and bearing assembly without disturbing piping connections.

1. Shall be rigidly coupled pipe-mounted types. Pump features shall include bronze impeller, alloy steel shaft, 100,000 hour ball bearings, cupro-nickel steel shaft sleeves, stuffing boxes, mechanical seals, 250 PSI test vertically split casings, flanged suction and discharge connections, rigid pump/driver coupling, coupling guard, motor driver and rigid pump-driver mounting baseplate and frame.
2. Pump volute shall be Class 30 cast iron, suitable for 175 PSI working pressure, with integrally-cast pedestal support feet. The impeller shall be cast bronze enclosed, double suction type, dynamically balanced, keyed to the shaft and secured by a locking cap screw.
3. The liquid cavity shall be sealed off at the pump shaft by an internally-flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225 deg. F. A replaceable bronze shaft sleeve shall completely cover the wetted area under the seal. Seals shall be capable of serviceability without disconnecting the pump from its piping.
4. Pump shall be rated for minimum of 175 psi working pressure. Volute shall have gauge tappings at the suction and discharge nozzles and vent and drain tappings at the top and bottom.
5. Pump bearing bracket shall have oil lubricated bronze journal and thrust openings. Bracket shaft shall be alloy steel having ground and hardened thrust bearing faces. A flexible coupling to dampen starting torque and torsional vibrations shall be employed.
6. Motor shall meet NEMA specifications and shall be of the size, voltage and enclosure called for on the plans. Pump and motor shall be factory aligned, and shall be realigned by the Contractor after installation prior to start-up.
7. Each pump shall be factory tested per Hydraulic Institute Standards. It

shall then be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.

D. End Suction Pumps: Pumps shall be base mounted, single stage, end suction design with a foot mounted volute to allow servicing of the impeller and bearing assembly without disturbing piping connections.

1. Pump volute shall be Class 30 cast iron with integrally-cast pedestal support feet. The impeller shall be cast bronze enclosed type, dynamically balanced, keyed to the shaft and secured by a locking cap screw.
2. The liquid cavity shall be sealed off at the pump shaft by an internally-flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225 deg. F. A replaceable bronze shaft sleeve shall completely cover the wetted area under the seal.
3. Pump shall be rated for minimum of 175 psi working pressure. Volute shall have gauge tappings at the suction and discharge nozzles and vent and drain tappings at the top and bottom.
4. Base plate shall be of structural steel or fabricated steel channel with fully enclosed sides and ends, and securely welded cross members. Grouting area shall be fully opened. A flexible type, center drop-out design coupler, capable of absorbing torsional vibration, shall be employed between the pump and motor. Coupler shall be shielded by a coupler guard securely fastened to the base.
5. Motor shall meet NEMA specifications and shall be of the size, voltage and enclosure called for on the plans. Pump and motor shall be factory aligned, and shall be realigned by the Contractor after installation.
6. Each pump shall be factory tested per Hydraulic Institute Standards. It shall then be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.
7. Shall be flexible coupled base-mounted types. Pump features shall include bronze impeller, alloy steel shaft, 100,000 hour ball bearings, cupro-nickel steel shaft sleeves, stuffing boxes, mechanical seals, 250 PSI test vertically split casings, flanged suction and discharge connections, flexible pump/driver coupling, coupling guard, motor driver and rigid pump-driver mounting baseplate and frame.

E. Shop Drawings shall include complete dimension drawings of all equipment furnished, together with individual pump curves, and electric data.

2.35 REGISTERS, GRILLES AND DIFFUSERS

A. Registers, grilles and diffusers shall be of model, size and capacity and furnished as scheduled on the drawings. Equipment shall be as manufactured by Titus, Tuttle & Bailey, Krueger or Metal-Aire and shall be supplied with white baked enamel finish except where noted otherwise.

B. All supply registers shall be furnished with individually adjustable face louvers. Registers and grilles shall be supplied with white baked enamel finish except where noted otherwise.

C. Diffusers, registers and grilles for installation in walls or plastered ceilings shall be provided with sponge rubber frame gaskets and Phillips head screws for attachment of device frame to building construction.

D. The diffuser shall be provided with a removable core permitting easy access to core sections. Diffuser neck shall extend no less than 1 inch above the core to accommodate an internal duct connection to prevent leakage to ceiling space. Diffusers shall be assembled in patterns which provide one, two, three or four-way air discharge with each side delivering a quantity of air proportional to the area served.

E. When indicated by manufacturer's model number on the equipment schedule, the ceiling diffusers shall be of the restricted multi-orifice jet induction and air mixing type consisting of louver sections with built-in diffusing vanes. The vanes shall be arranged to discharge air from adjacent louvers at an angle of 45 degrees in opposite directions to ensure rapid mixing of primary and room air. Each individual diffusing vane shall be welded in place and mechanically fastened to adjacent louver sections to make a rigid unit. The vanes shall extend to the discharge edges of the louvers. Where louver sections join core frame, the louver ends shall be welded to core frame. The leaving edge of each louver shall be hemmed and the louver ends shall be rounded and hemmed before welding the core frames.

F. All duct connections to registers, grilles and diffusers shall have all interior surfaces with the line of sight or within 4 feet of the opening painted with dull black paint.

2.36 ROOFTOP AIR HANDLING UNITS

A. General:
1. Rooftop units shall be as manufactured by Trane, York, Daikin or Carrier.
2. Units shall be specifically designed for outdoor rooftop installation on a roof curb and be completely factory assembled and tested, piped, internally wired, fully charged with R-410A compressor oil and shipped in one piece. Units shall be available for direct expansion cooling only, or direct expansion cooling with hot water heating. Filters, outside air system, exhaust air system, non-fused disconnect switches and all operating and safety controls shall be furnished factory installed. All units shall be cULus approved and factory run tested. Cooling capacity shall be rated in accordance with AHRI Standard 360. All units shall have decals and tags to aid in service and indicate caution areas. Electrical diagrams shall be printed on long life water resistant material and shall ship attached to control panel doors.

B. Casing:
1. Units shall be double-wall construction. Exterior panels shall be zinc coated galvanized steel, phosphatized and painted with a slate grey air-dry finish durable enough to withstand a minimum of 500 hours consecutive salt spray application in accordance with standard ASTM B117. Screws shall be coated with zinc-plus-zinc chromate. Heavy gauge steel hinged access panels with tiebacks to secure door in open position shall provide access to filters and heating sections. Refrigeration components, supply air fan and compressor shall be accessible through removable panels as standard. Unit control panel, filter section, and gas heating section shall be accessible through hinged access panels as standard. Double Wall Construction hinged access doors shall provide access to filters, return/exhaust air, heating and supply fan section. All access doors and panels shall have neoprene gaskets. Interior surfaces or exterior casing members shall have

1/2" Tuf-Skin fiberglass insulation. Unit base shall be watertight with heavy gauge formed load bearing members, formed recess and curb overhang. Unit lifting lugs shall accept chains or cables for rigging. Lifting lugs shall also serve as unit tiedown points.

C. Compressors:
1. The rooftop units shall be furnished with scroll compressors.
2. The scroll compressors shall have a simple mechanical design with only three major moving parts. Scroll type compression shall provide inherently low vibration. The scroll compressor shall include a direct-drive, 3600 rpm, suction gas cooled hermetic motor. Motor protection shall be provided by either a patented motor cap and integral line break motor protector or an external 24 VAC module which provides protection against incorrect phase sequence, excess motor temperatures, over current protection, and phase loss. The scroll compressor shall include centrifugal oil pump, scroll tips seals, internal heat shield that lowers the heat transfer from discharge and suction gas, oil level sight glass and oil charge valve. Compressor shall also be provided with a dip tube that allows for oil draining, in addition to a low leakage internal discharge check valve to help prevent refrigerant migration. Each compressor shall have a crankcase heater installed, properly sized to minimize the amount of liquid refrigerant present in the oil sump during off cycles.

D. Phase and Voltage Monitor:
1. Phase and voltage monitor shall be standard on all units, which shall protect 3-phase equipment from phase loss, phase reversal, and low voltage. Any fault condition will produce a Failure Indicator LED, and send the unit into an emergency stop condition. Phase and voltage monitor shall be cULus approved.

E. Evaporator Coil:
1. Evaporator coil shall feature an internally enhanced copper tubing of 3/8" or 1/2" O.D., which shall be mechanically bonded to heavy duty aluminum fins of configured design. All coils shall be equipped with thermal expansion valves and factory pressure and leak tested.

F. Air-Cooled Condenser Coil:
1. Condenser coils shall have all Aluminum Micro-channel coils. All coils shall be leak tested at the factory to ensure pressure integrity. The condenser coil is pressure tested to 650 psig. Sub-cooling circuit(s) shall be provided as standard.

G. Condenser Fans and Motors:
1. All condenser fans shall be vertical discharge, direct drive fans, statically balanced, with steel blades and zinc plated steel hubs. Condenser fan motors shall be three-phase motors with permanently lubricated ball bearings, built-in current and thermal overload protection and weather tight slingers over motor bearings.

H. Supply Fan:
1. All supply fans shall have two double inlet, forward-curved fans mounted on a common shaft with fixed sheave drive and shall be dynamically balanced

and tested in factory. Supply fan shall be test run in unit as part of unit test and unit shall reach rated rpm before the fan shaft passes through first critical speed. Fan shaft shall be mounted on two grease lubricated ball bearings designed for 200,000 hours average life. Extended grease lines shall allow greasing of bearings from unit filter section. Fan motor and fan assembly shall be mounted on common base to allow consistent belt tension with no relative motion between fan and motor shafts. Entire assembly shall be completely isolated from unit and fan board by 2" deflection spring isolation. All 60 Hz supply fan motors meet the Energy Independence Security Act of 2007 (EISA).

I. Unit Controller:

1. DDC microprocessor controls shall be provided to control all unit functions. The control system shall be suitable to control CV or VAV applications. The controls shall be factory-installed and mounted in the main control panel. All factory-installed controls shall be fully commissioned (run tested) at the factory. The unit shall have a Human Interface Panel with a 16 key keypad, a 2 line X 40 character clear English display as standard to provide the operator with full adjustment and display of control data functions. The unit controls shall be used as a stand-alone controller, or as part of a building management system involving multiple units.
2. The unit shall be equipped with a complete microprocessor control system. This system shall consist of temperature and pressure (thermistor and transducer) sensors, printed circuit boards (modules), and a unit mounted Human Interface Panel. Modules (boards) shall be individually replaceable for ease of service. All microprocessors, boards and sensors shall be factory mounted, wired and tested. The microprocessor boards shall be stand-alone DDC controls not dependent on communications with an on-site PC or a Building Management Network. The microprocessors shall be equipped with on-board diagnostics, indicating that all hardware, software and interconnecting wiring are in proper operating condition. The modules (boards) shall be protected to prevent RFI and voltage transients from affecting the board's circuits. All field wiring shall be terminated at separate, clearly marked terminal strip. Direct field wiring to the I/O boards is not acceptable. The microprocessor's memory shall be non-volatile EEPROM type requiring no battery or capacitive backup, while maintaining all data.
3. Zone sensors shall be available in several combinations with selectable features depending on sensor.
4. The Human Interface Panel's keypad display character format shall be 40 characters x 2 lines. The character font shall be 5 x 7 dot matrix plus cursor. The display shall be Supertwist Liquid Crystal Display (LCD) with blue characters on a ray/green background which provides high visibility and ease of interface. The display format shall be in clear English. Two or three digit coded displays are not acceptable.
5. The keypad shall be equipped with 16 individual touch-sensitive membrane key switches. The switches shall be divided into four separate sections and be password protected from change by unauthorized personnel. The six main menus shall be STATUS, SETPOINTS, DIAGNOSTICS, SETUP, CONFIGURATION and SERVICE MODE.

J. BACnet Communication Interface Module:

1. Rooftop units shall be provided with a BACnet communication interface

module, which shall provide control and monitoring of the rooftop by the building management system utilizing BACnet protocol.

K. Filters:
1. Units shall be furnished with 2” thick MERV 8 pre-filters and 4” thick MERV 13 final filters.

L. Return Fan:
1. The rooftop unit shall be furnished with a 100% modulating return fan with Statitrac Control.
2. A single width plenum fan with airfoil blade shall be mounted on a shaft with fixed sheave drive. The fan shall be dynamically balanced for the operating envelop and tested in factory before being installed in unit. The plenum fan shall be test run as part of unit final run test. Fan operating envelop rpm shall be below first critical speed. Fan shaft shall be mounted on two grease lubricated ball or roller bearings designed for 200,000-hour average life. Extended grease lines shall be provided to allow greasing of bearings from section base rail. Fan motor and assembly shall be mounted on common base to allow consistent belt tension with no relative motion between fan and motor shafts. The entire assembly shall be completely isolated from unit with 2" spring isolators. The 100 percent modulating relief damper shall be modulated in response to building pressure. A differential pressure control system, (Statitrac), shall use a differential pressure transducer to compare indoor building pressure to outdoor ambient atmospheric pressure. The (Statitrac) control system shall modulate the discharge dampers to control the building pressure to within the adjustable, specified deadband that shall be adjustable at the Human Interface Panel. The return fan VFD shall modulate in response to return duct static pressure. All 60 Hz return fan motors meet the Energy Independence Security Act of 2007 (EISA).

M. Variable Frequency Drive:
1. General Description: The VFD and all associated optional equipment shall be UL listed according to Power Conversation Equipment cULus. The AC Drive shall be designed, constructed and tested in accordance with NEMA ICS, NFPA, and IEC standards. The VFD shall be housed in a metal NEMA 1 enclosure. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. DC link reactors shall be provided on both the positive and negative rails of the DC bus equal to 3% impedance to minimize power line harmonics. Full load amp ratings shall meet or exceed NEC Table 430-150. The VFD shall provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting. Isolation is provided between the VFD power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. Audible motor noise shall be minimized through the use of an adjustable carrier frequency. Carrier frequency shall be automatically adjusted to optimize motor and VFD efficiencies while reducing motor noise. Operating range, ambient temperature, -10 to 50C (14 to 104F), 0 to 95% relative humidity, non-condensing, AC line voltage variation, -10 to +10% of nominal with full output.
2. Protective Features:
   a. Class 10 I2t electronic motor overload protection for single motor

applications shall be provided, which shall include: protection against input transients, loss of AC line phase, output short circuit, output ground fault, over-voltage, under voltage, AC Drive over-temperature and motor over-temperature.

b. All faults shall be displayed in plain English.
c. Protection from VFD sustained power or phase loss.
d. Full rated output with an input voltage as low as 90% of nominal.
e. Continuous operation with reduced output with an input voltage as low as 164 V AC for 208/230 volt units, 313 V AC for 460 volt units, and 394 volts for 600 volts units.
f. Semi-conductor rated input fuses to protect power components.
g. A "signal loss detection" circuit shall sense the loss of an analog input signal such as 4 to 20 mA or 0 to 10 V DC, and is programmable to react as desired in such an instance. Default: After 10-second time out the VFD will shut off.
h. VFD shall function normally when the keypad is removed while the AC Drive is running and continue to follow remote commands.
i. VFD shall catch rotating motor operating forward or reverse up to full speed.
j. The VFD shall be rated for 100,000 amperes interrupting capacity (AIC).
k. VFD shall include current sensors on three output phases to detect and report phase loss to the motor, which shall identify which of the output phases is low or lost.
l. VFD shall continue to operate without faulting until input voltage reaches 300 V AC on 208/230 volt units, 539 V AC on 460 volt units, and 690 volts on 600 volt units

3. Interface Features:
   a. Off/Stop and Auto/Start selector switches shall be provided to start and stop the VFD and determine the speed reference.
   b. On units with bypass, an AC Drive/Off/Bypass Hand selector switch shall be provided in the unit control box.
   c. In case of an external current overload, a normally closed dry contact shall stop the motor whether in DRIVE or BYPASS mode. In DRIVE mode, speed reference shall be provided by a 0 to 10 V DC analog input.
   d. The display shall be programmable to display in 9 languages including English, Spanish and French. The display has four lines, with 20 characters on three lines and eight large characters on one line.
   e. The following points shall be controlled and/or accessible:
      - VFD Start/Stop.
      - Speed reference.
      - Fault diagnostics.
   f. Meter points to include:
      - Motor power in HP.
      - Motor power in kW.
      - Motor kW-hr.
      - Motor current.
      - Motor voltage.
      - Hours run.
      - DC link voltage.

- Thermal load on motor.
- Thermal load on AC Drive.
- Heatsink temperature.

g. The VFD shall store in memory the last 10 faults and related operational data. Four simultaneous displays shall be available, frequency or speed, run time, output amps and output power. The following displays shall be accessible from the keypad:

- Reference Signal Value.
- Output Frequency in Hz or percent.
- Output Amps.
- Motor HP.
- Motor kW.
- kW hour.
- Output Voltage.
- DC Bus Voltage.
- AC Drive Temperature in degrees.
- Motor Speed in RPM.

4. Bypass control shall provide full nominal airflow in the event of drive failure.

N. 0-100 percent modulating economizer:

1. Modulating economizer shall operate through the primary temperature controls to automatically utilize OA for "free" cooling. Automatically modulated return and OA dampers shall maintain proper temperature in the conditioned space. Economizer shall be equipped with an automatic lockout when the outdoor high ambient temperature is too high for proper cooling. Minimum position control shall be standard and adjustable at the Human Interface Panel or with a remote potentiometer or through the building management system. A spring return motor shall ensure closure of OA dampers during unit shutdown or power interruption. Mechanical cooling shall be available to aid the economizer mode at any ambient. Low leak economizer dampers shall be standard with a leakage rate of 2.5 percent of nominal airflow (400 CFM/ton) at 1" wg. static pressure.

O. Ultra low-leak economizer dampers

1. Standard low leak dampers shall be provided with chlorinated polyvinyl chloride gasketing added to the damper blades and rolled stainless steel jamb seals to the sides of the damper assembly. Ultra low-leak economizer dampers shall have a leakage rate of one percent based on testing data completed in accordance with AMCA Standard 500 at AMCA Laboratories.

P. Economizer Control with Comparative Enthalpy

1. Used with the fresh air economizer, two enthalpy sensors shall be provided to compare total heat content of the indoor air and outdoor air to determine the most efficient air source when economizing.

Q. Hot Water Heating Coil:

1. Hot water coils shall be Type W and factory mounted in the rooftop unit to provide complete drainage of coil. Hot water modulating valve with actuator shall be provided.

R. Hot Gas Bypass:

1. Valve, piping and controls shall be included on circuit 2 to allow operation at

low airflow, avoiding coil frosting and damage to compressor. When suction pressure falls below valve adjustable set point, the valve modulates hot gas to the inlet of the evaporator.

T. Traq Sensor:

1. Rooftop units shall be provided with a Ventilation Control Module (VCM) to control the minimum fresh air entering the unit. The Ventilation Control Module (VCM) shall be linked to the Intellipak UCM. Using a velocity pressure sensing ring, the VCM shall monitor and control the quantity of fresh air entering the unit, which control the minimum outside airflow set point. A carbon dioxide sensor shall be connected to the VCM to control the carbon dioxide reset. cULus approved special feature.

U. Sloped Stainless Steel Drain Pan:

1. Rooftop units shall be provided with a double sloping stainless steel drain pan to promote runoff of standing water from condensation inside the unit. To insure maximum protection against condensation and standing water in the corners of the evaporator coil channel, two drain pipes shall be installed through the base channel on each side of the unit. Additional piping shall be connected to the drain pipes, which will allow the condensation to drain away from the unit and the top of the facility. The base pans in evaporator section of the unit shall be constructed of 16 gauge stainless steel. All non-stainless steel components in the base of the evaporator section shall be coated with air dried phenolic coating. The evaporator drain pan shall be constructed of 14 gauge stainless steel.

V. Roof Curb

1. Adjustable Spring Isolation Curb
   a. The Adjustable Spring Isolation Curbs that bear directly on the roof structure and are flashed and waterproofed into the roof's membrane waterproofing system. Equipment manufacturers or field fabricated curbs shall not be used. Curbs are based on ASI Curb as manufactured by Cambridgeport Air Systems.
   b. ASI Curb shall include the following features:
      (1) The Lower fixed Curb sides and ends shall be continuous 14 gauge G90 galvanized sheet metal. All sides, ends and corner joints shall be continuously welded.
      (2) Springs shall have a minimum outer diameter to overall height ratio of 0.8:1 at rated deflection. Reserve deflection (from published load ratings to solid height) of 50% of the rated deflection. Minimum ¼" thick neoprene acoustical base pad or cup on underside, unless designated otherwise. Spring pockets shall have integral restraining bolts with elastomeric cushions preventing metal-to-metal contact. Internal spring adjusting nut and bolt. Built-in all-directional limit stops with minimum 3/8" clearance under normal operation.
      (3) All spring locations shall have removable waterproof galvanized steel cover to allow for spring adjustment and/or replacement.
      (4) The Upper floating top rail shall be fabricated and formed of 10 gauge G90 galvanized steel.

(5) Shall be capable of accepting external insulation. All external insulation shall be furnished by the installing contractor.

(6) Waterproofing and air tightness shall be achieved by use of a metal counter flashing from the floating top rail in conjunction with a continuous flexible EPDM weather seal from the metal counter flashing to the bottom section. The EPDM weather seal will be factory installed.

(7) Wood nailer around the perimeter of the curb shall be supplied for the installing contractor. Curbs shall be installed based on the NRCA standards.

(8) Overhung condensing units shall be supported by structural steel stanchions with restrained spring isolators of the same deflection as the curb. These stanchions are to be attached directly to the building structure and provide a consistent mounting height relative to the RTU. Field fabricated (built-up) curbs supporting spring mountings shall not be used.

(9) Prefabricated galvanized pans for rooftop units that require drainage pans under the condensing sections that are located within the curb perimeter.

(10) Duct supports shall be provided by unit manufacturer. Supports shall be capable of supporting the duct work with a maximum deflection over the width of the curb of L/360.

(11) Removable Lifting lugs shall be attached to the top section.

(12) Seismic brackets located on floating top rail for unit attachment. Seismic brackets are adjustable to accommodate various base rails.

(13) Seismic attachment pads located on the lower section of the curb. Three Seismic attachment pads for each spring housing.

(14) Shall maintain the same installed and operating height with or without the equipment load and shall be capable of being utilized as a blocking device.

(15) Shall be fully assembled at the factory and shipped as one piece. Knock down version available upon request.

(16) Shall have a nominal deflection ranging from 1.00 inch to 3.00 inch. ASI Curb 100, 200 & 300.

(17) Shall have a minimum operating height of 26 inches.

(18) Provide with framed supply and return air duct openings. Openings shall match sizes given by the unit manufacturer.

2.37 SHEET METAL WORK

A. General: Ductwork systems shall be fabricated and installed in accordance with recommendations contained in the SMACNA “HVAC Duct Construction Standards”, Third Edition 2005, and as herein specified. Tables and figures referred to hereinafter are taken from the SMACNA publication.

B. Duct Pressure Classes: As shown on drawings. Where no specific duct pressure class designations are provided on drawings, the 2 inch water gauge pressure class is the basis of compliance with the standards, regardless of velocity in the duct, except when the duct is variable volume supply or designated exhaust. All variable volume ducts upstream of VAV boxes have a 3 inch WG basis of compliance when the drawings do not give pressure class. All AC unit discharge plenums of VAV systems shall have a 6 inch WG basis and the ductwork to the first branch take-off a 4 inch WG basis of compliance when the drawings to do indicate a pressure class. Negative pressure ductwork between lab hoods and exhaust fan inlet shall be 5 inch water gauge pressure class. Snaplock construction is not permitted. Refer to NFPA for Smoke Exhaust Ductwork Gauge Requirements.

C. Casings and Plenums: Casing and plenum sheet metal gauges, reinforcing and construction details shall be in accordance with Figures 6-1 through 6-12. Intake and exhaust plenums shall be sealed liquid tight and drained. Where through-louver drainage cannot be achieved, a 1 inch drain connection with serviceable 3 inch deep trap, shall be provided within a heated space to prevent freezing, and piped to the nearest floor drain. Bottom of plenums shall pitch toward drainage openings.

D. Hangers and Supports: Ductwork sheet metal supports shall be in accordance with Chapter IV, including all plenum and casing sheet metal which is suspended.

E. Sealing: All duct joints and air device connections shall be sealed in accordance with Table 1-2 except that all supply systems shall be sealed Class A. The sealant shall be Hardcast 550 with imbedded fabric, except for joints with dissimilar metals then a lead gasket shall be provided. Louver plenums shall be sealed water tight to a height of 12 inches above the plenum bottom.

F. Branch Take-Offs: Branch main take-offs for round ductwork shall be 45 degree lateral tap and where terminal boxes occur, shall be 45° angle entry in accordance with Figure 2-6.

G. Elbows: Elbows for round ducts shall be stamped type elbows with centerline radius equal to 1.5 times duct diameter. Where space is limited, the centerline radius may be reduced to 1.0 times the diameter for only those ducts entering into corridor ceiling spaces from vertical duct shafts. Elbows for rectangular and oval ductwork shall have a centerline radius equal to 1.5 times the duct width.

1. Where space is restricted and as approved in writing by the Engineer, square throat elbows with single or double thickness turning vanes may be used. Elbows shall be in accordance with Figure 2-2 except that throat types RE-4, RE-6, RE-7, RE-9 and RE-10 are specifically prohibited. Provide an access door upstream of all square throat elbows with single (or double) thickness turning vanes.

H. Transitions and Offsets: Transitions in round ducts shall be conical reducers. Transitions in rectangular ducts shall be in accordance with Figure 2-7 except that offset type 1 and offset type 2 are specifically prohibited.

I. Flexible Connections: Flexible connections shall be in accordance with Figure 2-17. Flexible connectors shall be installed to provide alignment of equipment and devices with ducts in operating positions. Provide on the inlet and outlet side of all air moving equipment incorporating rotating elements. Connections shall be of glass fiber

reinforced neoprene captured by a fingered metal band at each edge. Maintain a maximum three inch (3") separation and a minimum 1½ inch separation between the connected devices such that a standard four inch (4") connector will be installed slack.

J. Access Doors: Access doors in sheet metal ducts shall be provided with sash locks. Access doors in casings and plenums shall be provided with Type 2 locks (handles). All doors shall be hinged. Door insulation shall match adjacent casings. Doors shall be provided on all plenum and mixing sections, fire dampers, smoke dampers, combination fire/smoke dampers, reheat coils (inlet side), air valves and terminal filter equipment.

K. Volume Dampers: Volume dampers shall be in accordance with SMACNA except that, in addition to those indicated on drawings, each branch main and branch shall be provided with damper typical to locations indicated in Figure 2-1. Additional dampers shall be provided where shown on plans, details and where specified elsewhere. Damper gauge to be two (2) gauges heavier than the duct in which they are mounted. Provide with locking quadrants or push rods and pillow blocks as appropriate. Dampers shall be sufficiently large to extend the full width of the branch duct to which it is attached. Provide scooped profile.

L. Fire Dampers and Smoke Dampers: Fire and smoke dampers shall be in accordance with National Fire Code NFPA 90A Standard requirements and bear an Underwriters label. Dampers shall be installed in accordance with manufacturer's installation instructions. Dampers shall be UL listed, labeled, and shall be dynamic-static designed in accordance with UL Standard 555. Dampers shall be listed to support the appropriate fire rating required for wall and/or floor penetrations served. Dampers in lined ducts shall be in accordance with Figure 2-22. Where required as a condition of damper listing, provide slip joint. To permit breakaway, no screws, rivets, bolts or other fasteners shall be used; each joint shall have an access door as applicable. Provide an access door in the duct to service fusible link. Access doors for insulated ducts shall be double wall insulated sandwich type. Fire dampers shall be out of air stream Type B or C. Combination fire/smoke dampers may be used in lieu of separate dampers. All smoke dampers and combination fire/smoke dampers shall be furnished with electric actuators, and appropriate UL label. Provide 10 gauge welded sleeve where dampers can not be placed directly into the fire and/or smoke wall.

1. All smoke dampers and fire/smoke dampers shall be supplied with electric/electronic actuators, 165 degree F. "McCabe Link" (for use in general HVAC ductwork), 185 degree F. "McCabe Link" (for use in smoke control exhaust ductwork). All fire/smoke dampers shall be capable of being reset remotely. All fire/smoke dampers shall be supplied with one (1) end switch that will indicate both full closed and full open. All fire/smoke dampers shall fail open upon loss of control signal. All smoke dampers shall fail closed upon loss of control signal.
2. Except where specifically noted otherwise, the maximum permissible pressure drop for any fire damper at air flow quantity required by Design Documents shall not exceed 0.1 inches of water.
3. Except where specifically noted otherwise, the maximum permissible pressure drop for any smoke damper assembly at air flow quantity required by design documents shall be as follows:
   a. Up to 1,000 FPM — 0.05 Inches of Water
   b. 1,000 to 2,000 FPM — 0.10 Inches of Water

c. Over 2,000 FPM 0.20 Inches of Water

4. Damper sizes shall be adjusted accordingly where required to reduce pressure drop.
5. Installed dampers found to have pressure drops in excess of specified values shall be replaced at no additional cost to the Owner.

M. All fire, smoke and combination fire/smoke dampers shall be dynamically rated for the following conditions:

1.	Fan (VAV) Discharge to Terminal Units	3,500 FPM
2.	Fan (CV) Discharge to Reheat Coils	1,500 FPM
3.	Terminal Box/Reheat Coil Discharge to	
	a. Terminal Device	1,000 FPM
4.	Return/Exhaust Terminal Device	
	a. Register to fan inlet	1,800 FPM

N. Exposed Ductwork: All ductwork exposed to view, except in mechanical rooms, shall not be cross-broken or beaded. Where reinforcement can not be eliminated by using heavy duty gauge, it shall be internal. Seams shall be of non-standing type and duct shall be cleaned and degreased to accept application of paint.

O. Flexible Ductwork: Shall be manufactured in accordance with UL-181, Class 0 and the amended Standards of NFPA 90A. The flexible ductwork shall be tested and listed by UL under these standards.

1. Ductwork shall be fabricated of minimum 0.0065” thick, grade 3003 aluminum alloy incorporating a “0” temper.
2. Spiral construction shall incorporate a continuous grooved seam, flat pipe lock, doubled over, to create an effective triple locking joint. Double locking seams shall not be accepted.
3. Corrugations formed into the spiral tape impart rigidity and shall support duct flexibility. Corrugations shall not exceed 3% of the nominal duct diameter.
4. Joints for securing to ductwork and/or equipment collars shall incorporate a reinforcing band around the circumference of the flexible duct and its connection point. Self-tapping sheet metal screws shall extend through the reinforcing band through the connecting collar, sandwiching the flexible ductwork between. Final air sealant shall be provided by Hardcast 550 with imbedded fabric.
5. Where associated ductwork is specified to be insulated, matching thickness insulating jacket, complete with vapor barrier, shall be used.
6. Length of flexible duct shall not exceed 48 inches except where specifically noted otherwise on drawings.
7. Flexible ductwork shall not be used in conjunction with ductwork rated for 6 inches WG and higher. Flexible duct shall not be installed to penetrate any walls, ceilings, roofs, or floors.
8. The intent of this specification section is to allow the use of flexible ductwork as a final connection to a terminal device. Bends shall not exceed 90 degrees or have a radius less than inside diameter of duct.

P. Exhaust systems serving bathrooms, shower rooms and similar rooms where the exhaust air may contain a high moisture content shall be constructed of aluminum and shall be sealed watertight and pitched to prevent any accumulation of moisture. Provide a trapped drain at all low points and at the base of each riser.

Q. Exhaust systems serving laboratory exhaust hoods shall be constructed of Type 316 stainless steel with externally welded, liquid tight joints, unless indicated otherwise on the drawings.

R. Provide 24 gauge piping sheet metal protective covers, shields or saddles to protect piping insulation. Protective covers shall totally encapsulate any and all exposed HVAC piping within six feet (6') of finished floor. Shields and saddles shall extend a minimum of six inches (6") ahead and behind the projected footprint of the pipe support addressed and shall completely cover the lower 180° arc of the insulated piping.

S. Acoustic Liner:
1. All ductwork noted on plans t be acoustically lined, shall have one-inch (1") thick "ToughGard R" duct liner with enhanced surface. Acoustical liner shall be composed of rotary-type glass fibers for superior acoustic performance. The fibers shall be bonded together with a thermosetting resin into a insulation blanket which is overlaid with a durable, water repellent, fire-resistant black composite air stream surface.
2. Acoustic liner shall comply with ASTM C1071 for air velocities up to 6000 FPM.
3. Acoustic liner shall comply with ASTM C1104 for vapor sorption.

Note: Duct dimensions shown are of clear inside dimensions after application of liner.

2.38 SHEET METAL WORK (HIGH VELOCITY SYSTEMS)

A. General: High velocity systems shall be fabricated and installed in accordance with recommendations contained in the latest edition of the SMACNA "High Pressure Duct Construction Standards" and as herein specified. Tables and figures referred to hereinafter are taken from the SMACNA Publication.

B. Ductwork: Ductwork sheet metal gauges, transverse joint construction and intermediate reinforcing shall be in accordance with Figure 2-2 for round ductwork and Table 4-3 for rectangular ductwork with welded joints.

C. All duct joints shall be sealed in accordance with recommendations of Chapter 5 for the sealant used.

D. Supports: Ductwork sheet metal supports shall be in accordance with Chapter 6.

E. Branch Take-Offs: Branch main take-offs for round ductwork shall be 45 degrees lateral and where terminal boxes occur shall be conical tees in accordance with Figure 2-5.

F. Elbows, Transitions and Offsets: Elbows for round ducts shall be stamped type elbows with centerline radius equal to 1.5 times duct diameter. Where space is limited the centerline radius may be reduced to 1.0 times the diameter for only those ducts entering into corridor ceiling spaces from vertical duct shafts. Elbows for rectangular ducts shall be radius type in accordance with Chapter 4. Where space is restricted, square throat elbows may be used in accordance with Chapter 4. Transitions in round ducts shall be conical reducers. Transitions in rectangular ducts shall be in accordance with Figure 4-18.

G. Volume Dampers: Volume dampers shall be similar to those specified for low velocity ducts.

H. Fire dampers and smoke dampers shall be in accordance with Chapter 4 with the damper designed to be outside main air stream in a housing extension. Dampers shall be UL listed and labeled for appropriate fire rating required for rating of wall or floor penetration served. Dampers shall be provided with hinged access doors adjacent to linkages. Where fire dampers cannot be placed directly into fire wall, then 10 gauge black steel welded extension housing shall extend to actual damper location. Dampers shall be located in straight duct sections and installed in accordance with the manufacturer's installation requirements.

I. Flexible ductwork shall be in accordance with UL 181 Class 1 construction and shall be spiral wire reinforced fabric with liquid sealant and clamps to secure it to connecting ductwork or equipment collars. Where associated ductwork is specified to be insulated, insulating jacket, complete with vapor barrier, shall be used. Use manufacturer's recommendations for sealing and securing joints at insulated flexible ducts. When unsupported length of flexible duct exceeds 6 feet, provide 1½ inch galvanized sheet metal saddles under fiberglass duct with sheet metal or aluminum strap supporting saddles from structural framing above. In no case shall hanger spacing exceed 6 feet. Bends shall not exceed 90 degrees or have a radius less than inside diameter of duct

2.39 SLEEVES, INSERTS AND OPENINGS

A. General:
1. All penetrations for piping, ductwork and conduit in the building walls, floors and roof shall have sleeved or boxed openings except for interior wall of gypsum board and stud construction which are not fire or smoke rated.
2. The HVAC Subcontractor shall be responsible for informing this Contractor of the construction schedule as to permit orderly inclusion of all sleeves, openings and inserts. The HVAC Subcontractor shall furnish and install all sleeves, boxed openings and inserts as the work progresses. If the HVAC Subcontractor fails to provide the sleeves, boxed openings and inserts, he shall bear the cost of modifications necessary for their inclusion.
3. All cutting and patching shall be done by this Contractor. The HVAC Subcontractor shall not cut into any building construction without first having received permission from the Architect.

B. Sleeves:
1. This Contractor shall furnish all sleeves for the work and furnish all labor for installation.
2. Sleeves through exterior building walls or through concrete construction shall be Schedule 40 (galvanized) steel pipe. Sleeves through interior fire or smoke rated walls of gypsum and stud construction shall be 10 gauge sheet metal.
3. Sleeves shall be sized to provide a total of not less than 1/2 inch clearance around the piping, duct or conduit together with any insulation cover.
4. Sleeves for setting into walls shall be flush with finished construction. Sleeves for setting into floors shall be imbedded in concrete slab and extend approximately 1 inch above finished floors. Sleeves through floors of mechanical rooms shall be 12 gauge and shall extend 4 inches above the

floor. Sleeves shall be provided with lugs or flanges to permit firm attachment to the building construction. Wall sleeves shall not be used as support points.

5. All sleeved openings within the building shall be sealed airtight using fire barrier caulking with a UL classification for use as a fire barrier penetration seal for walls and floors with up to a three-hour fire rating, expanded into place for the full depth of the sleeve. Sleeved openings through exterior walls and floor shall also be sealed outside using waterproof mastic.

C. Inserts:

1. Inserts or other type anchoring devices shall be provided for the support of piping, ducts, or equipment in masonry or concrete construction. Inserts shall be as specified under pipe supports.
2. The HVAC Subcontractor shall furnish and install all inserts.

D. Openings:

1. Openings shall be framed or boxed by the HVAC Subcontractor.
2. Floor openings into mechanical rooms shall be provided with 4 inch high concrete curbs around the entire opening perimeter. All wall openings shall be flush with both surfaces.
3. Fire damper frames to be set into masonry or concrete construction shall be set into place at the time of the construction of the respective floor or wall. Exterior plywood covers shall be applied to both sides of fire dampers to prevent damage prior to making duct connections.
4. Openings for the passage of ducts and piping shall have 1/2 inch clearance all around the finished piping or duct and insulation. Boxed openings for gang piping shall be provided with 18 gauge sheet metal on both sides of penetration secured to the opening perimeter cut to fit the pipe shape and the clearance space within the opening filled with fire barrier caulking with a UL classification for use as a fire barrier penetration seal for walls and floors with up to a three-hour fire rating, expanded into place so as to make the penetration airtight.

E. Escutcheon Plates: Escutcheon plates shall be provided for all pipe penetrations into finished spaces as follows:

1. Pipe penetrations shall have chromium plated spun or pressed brass two-piece hinged escutcheon covers sized to fit the piping and insulation (if any) outside diameter and cover pipe sleeve.
2. Duct penetrations shall be 28 gauge stainless steel strips fastened with stainless steel screws or bolts and sized to cover the duct with any insulation and the wall opening. Round ducts shall be provided with escutcheon plates as indicated above for piping.
3. Penetrations through finished floors shall have matching finish extension escutcheon sleeves sized to the escutcheon and finished in a neat, workmanlike manner.

2.40 SOUND ATTENUATORS

A. Silencers shall be of the size, configuration, capacity and acoustic performance as scheduled on the drawings. All silencers shall be factory fabricated and supplied by the same manufacturer. Silencers shall be Vibro-Acoustics, IAC, United McGill or VAW.

B. Alternate manufacturers must request and obtain written approval by the Engineer to bid the project at least 10 days prior to the bid due date. As a condition of pre-approval, alternate manufacturers must submit to the Engineer a minimum of twenty (20) different HVAC silencer test reports. Each report shall be for a silencer tested in full accordance with the ASTM E-477-99 silencer test standard in an aero-acoustic test facility which is NVLAP accredited for the ASTM E477-99 standard. Each test shall have been conducted within the last 12 month period. A copy of the laboratory's NVLAP accreditation certificate must be included with the submitted reports. Any changes to the specifications must be submitted and approved in writing by the Engineer at least 10 days prior to the bid due-date.

C. Silencer inlet and outlet connection dimensions must be equal to the duct sizes shown on the drawings. Duct transitions at silencers are not permitted unless shown on the contract drawings.

D. Elbow Silencers: All elbow silencers, including models REFL shall be constructed with an HTL casing and 22 gauge galvanized perforated steel. All acoustical splitters shall be internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters are required as necessary to achieve the scheduled insertion loss. All elbow silencers with a turning cross-section dimension greater than 48" shall have at least two half splitters and one full splitter.

E. Rectangular Silencers:
   1. All rectangular silencers shall be constructed with a 22-gauge galvanized steel outer casing and 26 gauge galvanized perforated steel liner.

F. Acoustic Media:
   1. Media shall be of acoustic quality, shot-free glass fiber insulation with long, resilient fibers bonded with a thermosetting resin. Glass fiber density and compression shall insure conformance with laboratory test data. Glass fiber shall be packed with a minimum of 15% compression during silencer assembly. Media shall be bacteria and fungus resistant, resilient such that it will not crumble or break, and conforming to irregular surfaces. Media shall not cause or accelerate corrosion of aluminum or steel. Mineral wool will not be permitted as a substitute for glass fiber.

G. Media Protection;
   1. Media shall be encapsulated in glass fiber cloth to help prevent shedding, erosion and impregnation of the glass fiber.

H. Silencer materials, including glass fiber, shall have maximum combustion ratings as noted below when tested in accordance with ASTM E84, NFPA 255 or UL 723.
   1. Flamespread Classification: 15
   2. Smoke Development Rating: 5

I. Elbow silencers shall have high transmission loss (HTL) walls externally applied and completely sealed to the silencer casing by the silencer manufacturer to assure quality controlled transmission loss. The HTL walls shall consist of media, airspace, mass and 10-gauge outer protective metal skin to obtain the specified room noise criteria. Standard acoustical panels will not be accepted as HTL walls. If requested by the Engineer, breakout noise calculations for each air handling and fan system

shall be provided with the silencer submittal to insure compliance with the room noise criteria. Breakout noise calculations shall be based on the sound power levels of the specified equipment.

J. Silencers shall be constructed in accordance with ASHRAE and SMACNA Standards for the pressure and velocity classification specified for the air distribution system in which it is installed. Material gauges noted in "Section B Materials" are minimums. Material gauges shall be increased for the system pressure and velocity classification. The silencers shall not fail structurally when subjected to a differential air pressure of 8 inches water gauge.

1. Casings shall be lockformed and sealed, except as noted in Section B Materials, to provide leakage resistant construction. Airtight construction shall be achieved by u se of a duct-sealing compound supplied and installed by the Contractor at the job site.
2. All perforated steel shall be adequately stiffened to insure flatness and form. All spot welds shall be painted.

K. Acoustic Performance:

1. Silencer dynamic insertion loss shall not be less than that listed in the silencer schedule.
2. Silencer generated noise shall not be greater than that listed in the silencer schedule.
3. Acoustic performance shall include dynamic insertion loss and generated noise for forward flow (air and noise in same direction) or reverse flow (air and noise in opposite direction) in accordance with the project's air distribution system requirements.
4. All silencer ratings shall be determined in a duct-to-reverberant room test facility which provides for airflow in both directions through the test silencer in accordance with the ASTM E-477-99 test standard. The test set-up, procedure and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves and reverberation room absorption.

L. Silencer pressure drops shall not exceed those listed in the silencer schedule. Silencer pressure drop measurements shall be made in accordance with the ASTM E-477-99 test standard. Tests shall be conducted and reported on the identical units for which acoustical data is presented.

M. The manufacturer shall supply certified test data for each scheduled silencer. The data shall include dynamic insertion loss, generated noise and pressure drop for forward or reverse flow, matching the project's air distribution system requirement. All ratings shall be conducted in the same facility and shall utilize the same silencer.

1. Test facilities and test reports shall be open to inspection upon request from the Engineer. Silencer performance must have been substantiated by laboratory testing according to ASTM E477-99 and so certified when submitted for approval. The aero-acoustic laboratory must be NVLAP accredited for the ASTM E477-99 test standard. A copy of the accreditation certificate must be included with the submittals. Data from non-NVLAP accredited test facilities will not be accepted.

2.41 STRAINERS

A. Strainers shall be provided where shown on the drawings and as specified herein. Equipment shall be as manufactured by Sarco, RP&C, Mueller, Armstrong or Barnes and Jones.

B. Strainers shall be provided on inlets to all pressure regulating valves, temperature control valves and makeup water control valves. Strainer baskets shall be heavy duty perforated type with openings sized as recommended for the line size and service by the manufacturer. All strainers 2½ inch size and larger shall be provided with blow-down valves. Blow-down valves shall be ball valves, exception high and medium pressure steam service where gate valves specified for service shall be used. Blow-down valves shall have short nippled outlets angled down toward floor. Strainers on horizontal steam lines shall have to be installed with basket section installed horizontally and blow-down connections rotated to basket low point.

C. Strainers for all services, except as otherwise specified, shall conform to the following:
   1. Strainers on lines 2 inches and smaller shall have 250 working steam pressure bronze bodies with screwed ends.
   2. Strainers on lines 2½ inches and larger shall have 125 working steam pressure semi-steel bodies with flanged ends.

D. Strainers for high pressure steam and medium pressure steam service shall conform to the following:
   1. Strainers on lines 2 inches and smaller shall have 600 pound cast steel
   2. Strainers on lines 2½ inches and larger shall have 300 pound cast steel bodies with flanged ends

2.42 SUPPLEMENTAL SUPPORT SYSTEM

A. This Contractor shall provide all supplemental supports required to direct equipment and materials support loads to approved structural load bearing points. All mechanical equipment and systems shall be substantially supported without distortion or excessive vibration. The methods of support shall be as hereinafter described, except as otherwise noted on the drawings.

B. The supplemental support system shall be substantial type with members sized to prevent equipment distortion or excessive vibration. The HVAC Subcontractor shall provide support components such that all equipment shall operate without objectionable noise or vibration being transmitted to the structure.

C. The supplemental support system shall conform to requirements of this specification. Manufacturer's published characteristics referenced are intended as a guide only. The supplier shall verify support elements submitted are in accordance with specified materials and construction and are appropriately sized to accept and direct the proposed loading.

D. All supplemental support elements shall be by one (1) manufacturer: Unistrut, B-Line or Telestrut. The acceptable standard or quality shall be as follows:
   1. Framing Members:

a. Nominal Size: 1⅝" x 1⅝" "U" channel
b. Body: Mild Carbon Steel, ASTM A570 Grade 33
c. Gauge: 12 Gauge (0.105" thick)
d. Slot Width: 7/8" nominal
e. Pre-Punching: 9/16" Diameter, 1⅞" on center, 3 sides
f. Finish: Hot-Dipped Galvanizing, G90 weight, ASTM A123
g. Conformance: Metal Forming Manufacturers Association (MFMA) Standard Publication MFMA-1.

2. Fittings:
a. Nominal Size: 1⅝" (length per device)
b. Shape: Per Service from Manufacturer's Standard Catalog
c. Body: Hot Rolled Mild Carbon Steel, ASTM A570, Grade 33
d. Gauge: 1/4" Nominal Thickness
e. Hole Size: 9/16" Nominal
f. Finish: Hot Dipped Galvanizing, G90 weight, ASTM A123
g. Conformance: Metal Forming Manufacturer's Association (MFMA) Standard Publication MFMA-1

3. Accessories:
a. Nominal Size: Per Service from Manufacturer's Standard Catalog
b. Shape: Per Service from Manufacturer's Standard Catalog
c. Body: Hot Rolled Mild Carbon Steel, ASTM A570, Grade 33
d. Gauge: 1/4" Nominal Thickness
e. Hole Size: 9/16" Nominal
f. Conformance: Metal Forming Manufacturer's Association (MFMA) Standard Publication MFMA-1.
g. Rollers: Gray Cast Iron

4. Nuts and Bolts:
a. Nominal Size: 1/2" diameter x (Size per device)
b. Body: Mild carbon steel, ASTM A570, Grade 33, and Case Hardened
c. Threading: Coarse, Unified & American, UNC Classes 2A and 2B
d. Mounting: Spring or non-spring
e. Finish: Electro-Galvanized, G90 weight, ASTM A123
f. Conformance: Metal Forming Manufacturer's Association (MFMA) Standard Publication MFMA-1

E. Supplemental support system members shall be positioned to align with equipment support points for proper bolting.

2.43 TERMINAL BOXES

A. Single duct type with hot water coils:

1. Terminal Casing
Furnish and install Titus, Enviro-Tec, Nailor or Metal-Aire, single duct terminals of sizes and capacities (CFM) indicated on the drawings. Terminals shall be constructed of not less than 24 gauge zinc-coated steel, mechanically assembled and sealed to form an air-tight casing; maximum air leakage of 2 % at 3" w.g. Spot-welded casings are not acceptable. Interior walls of the terminal casing shall be lined with 1/2 -inch dual-density fiberglass with 4 pounds per cubic foot skin density, rated for a maximum air velocity of 4500 fpm. Insulation must meet all requirements of UL 181 and NFPA 90-A. Raw edges exposed to the airstream shall be coated and sealed. Sound power data shall be submitted with no corrections or noise

reduction factors applied.

2. Air Control Valve Assembly
Terminal air control valve shall be dual-wall construction, consisting of two (2) metal thicknesses with ½-inch dual-density insulation sandwiched between, creating an effective radiated sound barrier. Insulation shall be as specified for terminal casing. The control blade of the air valve shall be 16-gauge, designed to operate through a 45-degree arc. Multi-blade dampers and single blade volume controllers (operating through 90º) are not acceptable. The control blade shall be bolted or welded to a continuous shaft which rotates in self-lubricating nylon bearings. Blade shall close against a closed-cell gasket seat; it shall be preloaded to insure a tight seal. Blade shall not deflect at inlet pressures up to 6" w.g. Eliptical or oval dampers are not an acceptable substitution.

3. Controls
Terminal unit control shall be furnished by the ATC Contractor and factory installed by the terminal box manufacturer. See ATC Specification Paragraph 2.54. The terminal box manufacturer shall bear all costs associated with mounting the controls. Terminal boxes shall be provided with a sheetmetal control enclosure. Provide a factory-applied typed label unique to each VAV terminal box indicating DDC address, TAG, maximum flow setting, minimum flow setting.

4. Pressure-Independent Models with Pressure Differential Controller
Pressure differential reset controller shall maintain setpoint (CFM) within 5%, regardless of system pressure change. CFM limiting devices are not acceptable. The reset controller shall constantly monitor thermostat input, air flow (CFM), and system static and total pressures in a manner as to minimize under-or over-controlling in relation to the space temperature requirements. The reset controller shall be capable of field adjustment of minimum and maximum CFM settings without the use of tools. Flow curve for field balancing shall be affixed to terminal casing. Differential flow taps and factory-set CFM shall be provided is so noted at terminal schedule on the drawings. Controller shall maintain pressure independence to as low as .03" w.g. Averaging sensor shall be mounted in the inlet of the terminal and shall provide a minimum of one air pickup point for each 2-1/2" of inlet diameter. Single-point differential sensors are not acceptable.

5. Hot Water Coil
Terminals shall include a hot water coil. Coil shall be attached to the terminal with slip-and-drive connection, to allow removal for maintenance or cleaning. Coil shall be constructed of pure aluminum fins of .005" to .010" thickness, with die-formed spacers. Fins shall be mechanically fixed to .017" copper tubes for maximum heat transfer. Coils shall be tested at 320 p.s.i.g. air-under-water.

2.44 THERMOMETERS

A. Thermometers shall be of sizes, types and capacities specified herein, and shall be located as indicated on the drawings. Equipment shall be as manufactured by Taylor Company, Mueller Company or Foxboro Company.

B. Thermometers shall be industrial type with 9 inch scale, red perma colored liquid, black scale divisions on white background, union hub, separable brass well and adjustable swivel base. Provide extension wells on insulated lines. Locate wells so as to provide minimum restriction to flow.

C. Thermometer ranges shall be as follows:

Hot Water (All)	30-240 Degrees F.
Chilled Water	0-110 Degrees F.
Makeup Water	0-110 Degrees F.

Note: Mount all thermometers so as to be read from the floor. Provide two (2) spare thermometers of each range indicated.

2.45 UNIT HEATERS

A. Unit heaters shall be of sizes, capacities for the throw and mounting heights indicated on the drawings. Equipment shall be of manufacturer and size scheduled on the drawings, or approved equal as manufactured by Sterling, Vulcan, Rosemex or Rittling.

B. Horizontal unit heaters shall have direct driven propeller fan, steel fan guard, vertically adjustable louvers, horizontally adjustable fins and built-in motor thermal overload protection.

C. Vertical unit heaters shall have direct driven propeller fan, steel fan guard, adjustable outlet diffusers and built-in motor thermal overload protection.

2.46 VALVES

A. All valves shall conform to requirements of this specification for the services indicated. Manufacturer's numbers referenced are intended as a guide only. The supplier shall verify valves submitted are in accordance with specified materials and construction.

B. All valves of a given type shall be by one (1) manufacturer. The acceptable standard of quality shall be as follows.

C. Gate Valves: Jenkins, Grinnell or Crane

Nominal Size	Through 2"	2½" and above
Service	Chilled Water & Hot Water	Chilled Water & Hot Water
Pressure Rating	125 PSIG Steam, 200 PSIG WOG	125 PSIG Steam, 200 PSIG WOG
Body	ASTM B-62 Bronze; Threaded	ASTM A-126 Class B; Flanged
Bonnet	ASTM B-62 Bronze; Rising Stem	ASTM A-126 Class B; Bolted OS&Y
Bolts	N.A.	ASTM A-307
Gaskets	N.A.	Non-Asbestos Graphite/Aramid Fiber
Packing	Non-Asbestos Graphite/Aramid Fiber	Non-Asbestos Graphite/Aramid Fiber
Stem	ASTM B-371 Alloy C69400 or ASTM B-99 Alloy C65100 H04	ASTM B-16 UNS-C36000
Wedge	ASTM B-62 Bronze	ASTM A-126 Class B

		Cast Iron
Conformance	WW-V-54 Class A, Type I & MSS-SP-80	WW-V-58 Class 1, Type 1 & MSS-SP-70

D. Globe Valves: Jenkins, Grinnell or Crane

Nominal Size	Through 2”	2½” and above
Service	Chilled Water & Hot Water	Chilled Water & Hot Water
Pressure Rating	125 PSIG Steam, 200 PSIG WOG	125 PSIG Steam, 200 PSIG WOG
Body	ASTM B-62 Bronze; Threaded	ASTM A-126 Class B; Flanged
Bonnet	ASTM B-62 Bronze; Rising Stem	ASTM A-126 Class B; Bolted OS&Y
Bolts	N.A.	ASTM A-307
Gaskets	N.A.	Non-Asbestos Graphite/Aramid Fiber
Packing	Non-Asbestos Graphite/Aramid Fiber	Non-Asbestos Graphite/Aramid Fiber
Stem	ASTM B-371 Alloy C69400	ASTM B-16 UNS-C36000
Seat Disc	ASTM B-62 Bronze	ASTM B-584 Alloy C84400 Bronze or ASTM A-126 Class B Cast Iron
Seat Ring	N.A.	ASTM B-584 Alloy C84400 Bronze
Conformance	WW-V-51 Class A, Type I & MSS-SP-80	MSS-SP-85

E. Butterfly Valves: Jamesbury, Grinnell or Rockwell

	Two-Way	Three-Way
Nominal Size	3” and above	3” and above
Service	Bubble Tight, Dead End for Chilled Water & Hot Water	Bubble Tight, Dead End for Chilled Water & Hot Water
Pressure Rating	125 PSIG Steam, 200 PSIG WOG	125 PSIG Steam, 200 PSIG WOG
Body	ASTM A-395 60-40-18 or ASTM A576 65-45-12 Ductile Iron; Lug Style	ASTM A-395 60-40-18 or ASTM A576 65-45-12 Ductile Iron; Lug Style
Liner	Ethylene Propylene Diene Monomer	Ethylene Propylene Diene Monomer
Disc	ASTM A-351	ASTM A-351

Disc Coating	Ethylene Propylene Diene Monomer	Ethylene Propylene Diene Monomer
Shaft	ASTM A-276 Type 316 Stainless Steel	ASTM A-276 Type 316 Stainless Steel
Bearings	ASTM B-584 Alloy C93200 Bronze	ASTM B-584 Alloy C93200 Bronze
Bushings	ASTM B-584 Alloy C93200 Bronze	ASTM B-584 Alloy C93200 Bronze
Operator	Infinite Lever w/Memory Stop (to 6”φ); Chain Wheel w/Gear Operator (above 6”φ)	Chain Wheels w/Gear Operators Interconnected
Conformance	MSS-SP-67 & 46CFR56.20-15(b)(1)	MSS-SP-67 & 46CFR56.20-15(b)(1)

F. Ball Valves: Jamesbury, Grinnell or Watts

Nominal Size	To 3” φ
Service	Chilled Water & Hot Water
Pressure Rating	125 PSIG Steam, 400 PSIG WOG
Body	ASTM B-584 Alloy 845 Bronze, Threaded (to 2”φ) or Soldered (2½”φ & 3”φ)
Thrust Washer	Reinforced Polytetrafluoro ethylene
Ball	ASTM B-584 Alloy 845 Bronze; Full Port
Seats	Reinforced Polytetrafluoro ethylene (Teflon)
Stem	ASTM B-371 Alloy 694 Silicon Bronze
Packing	Reinforced Polytetrafluoro ethylene (Teflon)
Packing Nut	ASTM B-16
Operator	Infinite Lever w/Memory Stop
Conformance	WW-V-35, Type II, Class A, Style 3

G. Swing Check Valves: Grinnell or Watts

Nominal Size	2½” and above
Service	Chilled Water & Hot Water
Pressure Rating	125 PSIG Steam, 200 PSIG WOG
Body	ASTM A-126 Class B; Flanged
Bonnet	ASTM A-126 Class B; Bolted
Bolts	ASTM A-307
Gaskets	Non-Asbestos Graphite/Aramide Fiber
Disc	ASTM B-584 Alloy C84400 Bronze
Hanger	ASTM B-584 Alloy C84400 Bronze
Seat Ring	ASTM B-584 Alloy C84400 Bronze
Conformance	MSS-SP-71 Type I

H. Silent Check Valves: Grinnell or Watts

Nominal Size	2½" and above
Service	Chilled Water & Hot Water
Pressure Rating	125 PSIG @ 200°F., 230 PSIG WOG
Body	ASTM A-48 Class 35; Globe Style, Flanged
Stem	ASTM A-582 Alloy S30300 Stainless Steel
Disc	ASTM B-584 Alloy 836 Bronze
Spring	ASTM A-313 T304 Stainless Steel
Seat Ring	ASTM B-584 Alloy 836 Bronze
Conformance	N.A.

I. Temperature Control Valves: Shall be provided by the Automatic Temperature Control Subcontractor in conformance with the standards specified above. Valves shall be installed by the HVAC sub-contractor in accordance with the requirements of the ATC Subcontractor.

J. Valves five inches (5") and larger shall be independently supported.

K. Sprocket Wheels and Chains: Sprocket wheels and chains shall be furnished and installed on all hand operated valves 2½ inches in diameter and larger which can not be operated from any mechanical room floor.

2.47 VARIABLE FREQUENCY DRIVES

A. General
1. The Contractor shall provide a complete adjustable frequency controller as indicated on the drawings.
2. The Contractor shall be responsible for the installation and start-up of the equipment covered by this specification.
3. The adjustable frequency controller shall be furnished by a single vendor who has actively been manufacturing adjustable frequency controllers for a period of at least five (5) years.
4. Complete drawing shall be furnished for approval and shall consist of master wiring diagrams, elementary or control schematics, including coordination with other electrical control devices operating in conjunction with the adjustable frequency controllers. Suitable outline drawings showing details necessary to located conduit stub-ups and field wiring shall be furnished for approval before proceeding with manufacture.
5. The adjustable frequency controller shall be UL and CSA certified and shall comply with the latest applicable standards of ANSI, IEEE, NEMA and national Electrical Code.
6. Adjustable frequency controller manufacturer shall maintain and staff engineering service, within one hundred (100) actual miles of the site, to provide start-up service, emergency service calls, repair work, service contracts, maintenance and troubleshooting training of customer personnel.

B. Construction
1. The adjustable frequency controller shall be rated 460 volt, 3 phase, with feature and options as specified.
2. The adjustable frequency controller shall be rated for the motor HP as shown on the drawings. The controllers shall provide digitally-based speed

adjustment of three phase motors. The adjustable frequency and voltage output shall provide constant volts per hertz excitation of the motor up to 60 hertz.

3. The adjustable frequency controllers shall have a 110% overload rating for one (1) minute, every ten (10) minutes and a 140% overload rating for two (2) seconds, every fifteen (15) seconds.
4. The controller shall be capable of converting incoming 3 phase, 460 volt (+10%) and 60 hertz (+/- 2 hertz) power to a fixed potential DC bus level. The DC voltage shall be inverted by a full wave diode bridge rectifier or a pulse width modulated (PWM) inverter to an adjustable frequency output. The controller shall maintain power factor at .95 or greater at any speed or load. The controller shall have a minimum efficiency of 95% at rated load. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan (variable torque) control.
5. The adjustable frequency AC controller shall employ a full wave rectifier to prevent line notching, for conversion of AC power to DC power. The inverter section shall use Insulated Gate Bipolar Transistors (IGBT) (p -n substrate) as switching devices. The IGBT, operating as a MOS-gated, input inverted Darlington transistor with a MOSFET (n -n substrate in n-channel enhancement mode) input shall support high input impedance, low drive power and fast (40+k/sec) switching speeds. The bipolar output stage shall enable low conduction losses with high currents. A DC bus choke and DC capacitors shall control internal harmonic generation.
   a. Silicon controller rectifies (SCR's), current source inverters and paralleling of devices are unacceptable.
6. Sine wave approximation and voltage vector control shall be used to allow operation at rated motor shaft output at nominal speed with no de-rating. This voltage vector control shall be designed to minimize harmonics to the motor to maximize motor efficiency and life.
7. The inverter shall operate in an ambient temperature of 0ºC to 40ºC for elevations up to 3,300 feet above sea level and humidity of 0% to 95% non-condensing.
8. The controller enclosure shall be NEMA 1, wall-mounted. The controller shall have easily removable assemblies and shall be front accessible. No side clearance shall be required for cooling of wall mount units and all power and control wiring shall be done from the bottom.
9. All enclosures shall be not less than 16-gauge steel with surfaces to be thoroughly cleaned and phosphatized prior to painting. They shall be primed with a corrosion-resisting coating. Cabinet finish paint to be ANSI 161.
10. Doors shall include plastic device holders for mounting up to six (6) operator devices. Factory mounted operator devices shall be factory wired.
11. The operating handle of the disconnect switch shall always remain connected to the breaker and shall not be mounted on the door. The position handle shall indicate ON, OFF or TRIPPED condition of the circuit breaker. The handle shall have provisions for padlocking in the Off position with at least three (3) padlocks. Interlock provisions shall prevent unauthorized opening or closing of the controller door with the disconnect handle in the ON position.
12. All logic control boards shall be interchangeable.
13. The VFD and options shall be tested to ANSI/UL Standard 508. the complete VFD, including all specified options, shall be listed by a nationally recognized testing agency such as UL, ETL.

14. The VFD's full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for sixty (60) seconds and 220% of rated current for up to one (1) second while starting.
15. Drive shall be capable of operating a motor up to 1,000 feet away without de-rating or field modification. Provide detuning output filters and shielded cabling.

C. Interface
1. Start, stop and speed control potentiometer terminations.
2. Linear independent timed acceleration and deceleration adjustable.
3. Non-isolated process signal follower for 0-10 VDC control of output frequency.
4. Variable torque performance from 2 to 60 hertz.
5. Frequency stability of 0.5% for twenty-four (24) hours with voltage regulation of +/-2% of maximum rated output voltage.
6. Individual door-mounted lights or LED's for indication of run, power on and interruption due to over-current, over-voltage, over-frequency, under-voltage, over-temperature and phase loss.
7. 115 volt AC isolated control power for operator devices.
8. Motor slip dependent speed regulation.
9. Logic power carryover during utility loss shall be sufficient to extend double the interval required for internal losses to decay the load inertia to zero.
10. Insensitive to input line rotation.
11. Fixed dwell time at start to increase motor starting torque.
12. Auto restart to automatically restart on phase loss, over-voltage and under-voltage trips only.
13. Local/Hand, Stop/Reset and Remote/Auto selector switches shall be provided to start and stop the drive and determine the speed reference.
14. Provide a 24 VDC, 40 mA max, output signal to indicate that the drive is in Remote/Auto mode.
15. Digital manual speed control. Potentiometers are not acceptable.
16. Lockable, alphanumeric backlit display keypad. VFD's up to 300 HP shall use the same control panel.
17. A quick setup menu with preset parameters shall be provided on the drive.
18. The drive shall be fitted with RS 485 serial communications port and be supplied with software to display all monitoring, fault, alarm and status signals. The software shall allow parameters changes to be made to the drive settings, as well as storage of each controller's operating and setup parameters.
    a. The drive shall be fully able to communicate with PLC's, CDS's and DDC's. DDC's shall be able to monitor drive feedback signals which shall include, but shall not be limited to:
        1) Output Speed/Frequency
        2) Current (in amperes)
        3) Torque
        4) Power
        5) Kilowatt-Hours
        6) Relay Outputs
        7) Diagnostic Faults
19. The RS 485 serial communications port and software shall allow parameter changes to be made to the drive settings, as well as storage of each controller's operating and setup parameters.
    a. Serial communications shall include, but shall not be limited to:
        1) Run-Stop Control

2) Speed Set Adjustment
3) Proportional-Integral Controller Adjustment
4) Current Limit
5) Acceleration/Deceleration Time Adjustment.

20. Set point control interface (Proportional-Integral-Derivative (PID) control) shall be standard in the unit.
21. Floating point control interface shall be provided to increase/decrease speed in response to switch closures.
22. An elapsed time meter with kWh meter shall be provided.
23. The following displays shall be accessible from the control panel in actual units.
    a. Reference Signal Percent
    b. Output Frequency
    c. Output Amps
    d. Motor Horsepower
    e. Motor Electrical Demand (kW)
    f. Motor Electrical Energy Consumption (kW-hr)
    g. Output Voltage
    h. Drive Temperature (% until trip)
    i. Motor speed expressed in engineering units per application (in percent speed, GPM, CFM).
24. Drive will sense the loss of lead and signal a no load/broken belt warning or fault.
25. The VFD shall store in memory the last three (3) minimum faults and record all operational data.
26. Minimum six (6) programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
27. Minimum six (6) programmable relay outputs shall be provided for remote indication of drive status.
28. Two (2) programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include 0-10 VDC, 0-20 mA and 4-20 mA.
29. Two (2) programmable analog outputs shall be provided for indication of drive status. These outputs shall be programmable for output speed, voltage, frequency, amps and input kW.
30. The VFD shall accept an external contract closure command. Through an integrally mounted Interface Terminal Block (ITB), to automatically disable the VFD and transfer the motor to full line signal. Automatic by pass shall be used to permit the facility fire alarm system to override the normal VFD operation and default to nominal motor speed.

D. Protective characteristics
1. Input AC circuit breaker with an interlocked pad lockable handle mechanism.
2. AC input line current limiting fuses for fault current protection of AC to DC converter section.
3. Electronic cover-current trip for instantaneous overload protection.
4. AC input line under-voltage and phase loss protection.
5. Over-frequency protection.
6. Over-temperature protection.
7. Surge protection form input line transients.
8. Electrical isolation between the power and logic circuits, as well as between

the 1150 volt AC control power and the static digital sequencing.

9. Ability to withstand output terminal line-to-line short circuits without component failure.
10. dV/dT and dI/dT protection for converter semi-conductors.
11. Class 20 I^2t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications.
12. Protection against input transients, loss of AC line phase, short circuit, ground fault, over voltage, under voltage, drive over temperature and motor over temperature. The VFD shall display all faults in plain English. Codes are not acceptable.
13. Protect VFD from sustained power or phase loss. The VFD shall incorporate a five (5) second control power loss ride through to eliminate nuisance tripping.
14. The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.
15. Drive shall have semi-conductor rated input fuses to protect power components.
16. The drive shall be fitted with output line reactors to limit the rate of output voltage rise over time (dv/dT), reduce motor operating temperature and RFI and EMI. To prevent breakdown of the motor winding insulation, the dV/dT must be below 1500 V/μsec per IEC recommendations. The supplier shall include with the quotation the dV/dT values of the drive.
17. Drive shall be capable of starting into a rotating load operating forward or reverse up to full speed. VFD shall be capable of accelerating or decelerating to set point without safety tripping or component damage (flying start).
18. VFD shall be rated for 100,000 amp interrupting capacity (AIC).

E. Independent Adjustability

1. VFD shall have an adjustable carrier frequency of 1 to 12 kHz through 75 HP and 3 kHz (fixed) above 75 HP.
   a. Minimum Speed: 4 to 60 hertz.
   b. Maximum Speed: 40 to 90 hertz/
2. Three (3) variable-torque V/Hz patterns shall be provided with the ability to select a constant torque start pattern for each of them.
   a. Volts per hertz: Adjustable from 3.83 to 11.5 volts per hertz.
3. Twenty (20) preset speeds shall be provided.
4. Minimum two (2) acceleration and two (2) deceleration ramps shall be provided. The shape of these curves shall be adjustable.
   a. Acceleration: .5 to 30 hertz per second with ranges of 2-120 seconds for 0-60 Hz.
   b. Deceleration: .5 to 30 hertz per second with ranges of 2-120 seconds for 0-60 Hz.
   c. The VFD shall also accept remote input acceleration and deceleration rams via direct digital programmable inputs.
5. If VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset and restart.
   a. Over voltage.
   b. Under voltage.
   c. Current limit.
   d. Inverter overload.

e. Motor overload.
f. Loss of input signal.

The number of restart attempts shall be selectable from 9 to 5 (minimum) and the time between attempts shall be adjustable for 0 to 120 seconds.

6. Four (4) current limit setting shall be provided.
7. Low frequency Boost: Up to 60 volts at 2 Hz.

F. Bypass

1. Provide a manual by pass consisting of a door interlocked main fused disconnect pad lockable in the off position, a built-in motor starter and a four position DRIVE/OFF/LINE/TEST switch controlling three contactors.
   a. The DRIVE position shall allow the motor to be operated at an adjustable speed form the drive.
   b. The OFF position shall allow the motor and drive to be disconnected.
   c. The LINE position shall allow the motor to be operated at full speed form the AC power line. Power shall be disconnected from the drive, so that service can be performed.
   d. The TEST position shall allow the motor to be operated at full speed from the AC line power. This shall allow the drive to be given an operational test while continuing to run the motor at full speed in bypass.
2. External normally closed dry contact shall be interlocked with eh drives safety trip circuitry to stop the motor whether the DRIVE or BYPASS mode in case of an external safety fault.

G. Required Options

1. Full time adjustable current limit shall sense an overload on the motor when current exceeds a preset limit. Output frequency, and therefore motor speed, shall be reduced. If current decreased with speed, the speed shall decrease until current drops below the limit. Once current is reduced to normal, the frequency shall return to the original setting.
2. AC output contactor.
3. Motor over current relay.
4. Isolated process signal follower for use with grounded input process signal.
5. Output load ammeter, voltmeter and speed indicating meters.
6. Door mounted NEMA 4 operator controls with heavy duty industrial rated devices.
7. Process control output signal of 0-10 VDC, proportional to controller frequency, including gains and bias adjustments.
8. Controller status relay with two (2) Form C relay pairs, rated 2 amps resistive at 115 volt AC for indication of "ON" condition.
9. Bypass contactor arrangement with overload relay complete with all control circuitry to disconnect the controller from the motor and reconnect the motor to line power, after a suitable time delay, when initiated manually.

H. Quality Assurance

1. To ensure quality and minimize infantile failures at the job site, the complete VFD shall be tested by the manufacturer. The VFD shall operate a dynamometer at full load and the load and speed shall be cycled during the test.
2. All optional features shall be functionally tested at the factory for proper

operation.

3. Provide a written copy of the factory start-up results for inclusion in the close-out documentation.

I. Compliance to IEEE-519

1. The variable (adjustable) frequency drive manufacturer shall provide calculations specific to this installation showing that the Total Harmonic Distortion for the VFD's, reflected into the electrical distribution system is limited to the level defined by IEEE-519 (latest edition) for general systems. Harmonic analysis shall be included with VFD submittal to support the request for approval from the Engineer.
   a. The calculations shall proceed from Owner-provided power quality and harmonics information for all retrofit, renovation and restoration projects.
2. The VFD manufacturer shall conduct on-site harmonic measurements before and after start-up of the VFD's. Results of the measurements, showing the harmonic contribution of the VFD's, shall be provided to the Engineer as part of the Project Commissioning, prior to Final Acceptance by the Owner.
3. If site measurements show that the IEEE-519 levels have been exceeded:
   a. New Facilities:
      1) The VFD manufacturer shall provide proper filtering to attain the IEEE-519 levels, at no additional cost to the Owner.
   b. Existing Facilities:
      1) Should the quality of the existing power be consistent with the Owner-provided information, the VFD manufacturer shall provide proper filtering to attain the IEEE-519 levels, at no additional cost to the Owner.
      2) Should the quality of the existing power be inconsistent with the Owner-provided information, the VFD manufacture shall provide recommendations concerning proper filtering to attain the IEEE-518 levels, for consideration by the Owner.
4. Three phase alternating current input line reactors shall be provided as a minimum with all VFD's. The line reactors are to provide attenuation of the line side voltage transients, and shall prevent overload trips or other unnecessary VFD shutdowns, and provide a reduction in harmonic distortion.
5. Inlet line reactors shall be:
   a. 2-1/2% line impedance (minimum).
   b. 150% continuous current rating for one (1) minute.
   c. Saturation rating of not less than 2.5 times the continuous current rating.
   d. UL listed.

J. Approvable Manufacturers: The variable (adjustable) frequency AC drives shall be manufactured by Graham, Square D, Asea Brown Boveri, Cutler Hammer or Mitsubishi.

K. The HVAC Subcontractor shall provide written confirmation of coordination of drives and motor starters of all equipment with the Electrical Subcontractor.

2.48 VIBRATION ISOLATION AND SEISMIC RESTRAINTS

A. Provide vibration isolation and seismic restraint systems as identified by the requirements of this section and the contract documents. Attention is directed to the structural, architectural, mechanical and electrical documents which identify HVAC equipment and systems requiring vibration isolation treatment and seismic restraint.

B. The HVAC Subcontractor shall provide vibration isolation components such that all equipment shall operate without objectionable noise or vibration being transmitted to the structure.

C. The HVAC Subcontractor shall provide seismic restraint of non-structural building components (HVAC). Restraint systems are intended to withstand the stipulated seismic accelerations applied through the component's center of gravity.

D. The work in this section includes the following:
1. Vibration isolation elements for equipment.
2. Equipment isolation bases.
3. Piping flexible connectors.
4. Seismic restraints for isolated equipment.
5. Seismic restraints for non-isolated equipment.
6. Certification of seismic restraint designs and installation supervision.
7. Conform to vibration isolation and seismic restraint types herein specified.

E. Examine the contract documents for sizes, horsepowers, rotational speeds, equipment location, length of span between columns and beams and construction type to determine the isolator selection type and deflection required for each piece of mechanical equipment.

F. Conform to the requirements of the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Handbooks, "HVAC Applications" 1995 Edition; Chapter 43 "Sound and Vibration Control", and Chapter 50 "Seismic Restraint Design".

G. Isolators and restraints of the same type shall be the product of the same manufacturer. The manufacturer shall publish and maintain a full line of materials, engineering and application data and operating and maintenance instructions.

H. Seismic Certification and Analysis:
1. Seismic restraint calculations must be provided for all connections of equipment to the structure. All performance of products with restraints must be supported with manufacturer's data sheets or certified calculations.
2. Seismic restraint calculations must indicate specific code paragraph references (see CODE AND STANDARDS REQUIREMENTS) for each acceleration criteria. Seismic calculations shall indicate the component values required to determine the force to be restrained ($F_p = A_v\ C_c\ P\ a_c\ W_c$). Specifically, A_v value from Contour Map, USE GROUPS, SEISMIC HAZARD EXPOSURE GROUP, SEISMIC PERFORMANCE CATEGORIES, MECHANICAL, ELECTRICAL COMPONENT AND SYSTEM SEISMIC COEFFICIENT (C_c) Attachment Amplification Factor (a_c) AND PERFORMANCE CRITERIA FACTOR (P) must be determined and the resultant values shall be clearly indicated in the certified calculations. Note: For roof mounted equipment both the seismic acceleration and wind load shall be calculated, the highest load shall be utilized for the design of the restraints and isolators.

3. Seismic restraint calculations must be provided for all connections of equipment to the structure. Performance of all products associated with restraints must be supported with manufacturer's data sheets or certified calculations.
4. Seismic restraint calculations must be based on the acceleration criteria shown in **TABLE A** acting through the equipment's center of gravity.
5. For roof mounted equipment both the seismic acceleration and wind loads (30 psf) shall be calculated, the highest load shall be utilized for the design of the restraints and isolators.
6. Certification of calculations to support seismic restraint designs must be stamped by a professional engineer registered to practice in the Commonwealth of Massachusetts, with at least five years of seismic design experience.
7. Analysis must indicate calculated dead loads, derived loads and materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or weld length.
8. An in-force $1,000,000.00 coverage limit Seismic Design Errors and Omissions insurance certificate must accompany submittals. Manufacturer's product liability insurance certificates are not an acceptable substitution.

I. Manufacturer of vibration isolation and seismic control equipment shall assume the following responsibilities:
1. Determine vibration isolation and seismic restraint sizes and locations.
2. Provide equipment vibration isolation and seismic restraints as specified. Furnish manufacturer's product data covering each isolator and restraint type for style, characteristics, and finish.
3. Guarantee specified isolation system deflections.
4. Provide installation instructions, drawings and field supervision to insure proper installation and performance of systems.
5. Isolator quantities, dimensions, deflections, capacities and type shall remain the responsibility of the manufacturer and the Contractor.

J. Provide project specific catalog cuts and/or data sheets on the vibration isolators and restraints proposed for inclusion on this project. Reference each and every "TYPE" and detail each compliance with this specification.
1. Provide an itemized list of all isolated and non-isolated equipment. Provide detailed schedules showing isolator and seismic restraints proposed for each piece of equipment, referencing material and seismic calculation drawing numbers.
2. Show base construction for equipment; include dimensions, structural member sizes and support point locations.
3. When walls and slabs are used as seismic restraint locations, details of acceptable methods for duct and pipe must be included.
4. Indicate isolation devices selected with complete dimensional and deflection data before condition is accepted for installation.
5. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
6. Coordination or contract drawings shall be marked-up with the specific locations and types of restraints shown for all pipe and duct. Rod bracing at various installation angles and assigned load at each restraint location shall be clearly delineated. Any and all tributary loads shall be considered for proper restraint sizing.
7. For ceiling suspended equipment provide minimum/maximum installation

angle allowed for restraint system as well as braced and unbraced rod lengths at each allowable installation condition.

8. Calculate thrust for fan heads, for axial and centrifugal fans, to determine whether thrust restraints are required.

K. Housekeeping pad attachment shall be by the project Structural Engineer. Material and labor required for attachment and construction shall be by the Division 3 subcontractor.

1. Housekeeping pads shall be coordinated with the Seismic Restraint vendor and sized to provide a minimum edge distance of 10 bolt diameters of clearance all around the outermost anchor bolt to allow for the use of full anchor ratings.

L. Supplementary support steel and connections shall be provided by the HVAC Subcontractor for all equipment, piping, ductwork, including roof mounted equipment, as specified.

M. The HVAC sub-contractor shall provide restraint attachment plates to the General Contractor, to be cast into housekeeping pads, concrete inserts, and double sided beam clamps by the Division 3 Subcontractor, in accordance with the requirements of the Seismic Restraint vendor.

N. Definitions:

1. The term EQUIPMENT will be used throughout this specification and it includes ALL non-structural HVAC components within the facility and/or serving this facility, such as equipment located in out buildings or outside of the main structure on grade within five feet of the foundation all. Equipment buried underground is excluded. Entry of services through the foundation walls is included. Equipment requiring vibration isolation and seismic restraint includes, but is not limited to, the following:
   a. Air cooled condensing units
   b. Rooftop air handling units
   c. Air separators
   d. Boilers
   e. Cabinet heaters
   f. Ductwork
   g. Fans (all types)
   h. Motor control centers
   i. Piping
   j. Pumps (all types)
   k. Rooftop units
   l. Tanks (all types)
   m. Unit heaters
   n. Variable frequency drives
   o. Chillers
   p. Cooling towers
   q. NOTE: HVAC equipment and systems not listed herein above are still included in this specification.
2. Life Safety Systems defined:
   a. All systems involved with fire protection such as fire dampers.
   b. All systems involved with and/or connected to emergency power supply including smoke evacuation.
   c. All medical and life support systems.

d. Fresh air relief systems on emergency control sequences including air handlers, ductwork, and dampers.

3. Positive attachments are those locations at which equipment, piping, and ductwork are tied to the facility structural elements by incorporating:
   a. Cast-in or wedge type expansion anchors, or
   b. Double sided beam clamps, or
   c. Welded or through bolted connections to the structure.
4. Transverse bracing are those restraints applied to limit motion perpendicular or angular to the centerline of the pipe or duct.
5. Longitudinal bracing are those restraints applied to limit motion along the centerline of the pipe or duct.

O. Substitution of internally or externally isolated and restrained equipment in lieu of the isolation and restraints specified in this section is acceptable provided all conditions of this section are met. The equipment manufacturer shall provide a letter of guarantee from their Engineering Department stamped and certified per the section on Seismic Restraints and Analysis stating that the seismic restraints are in full compliance with these specifications. Letters from field offices or representatives are unacceptable.

1. All costs for converting to the specified vibration isolation and/or restraints shall be borne by the equipment manufacturer in the event of non-compliance with the preceding.
2. In the event that the equipment is internally isolated and restrained, the entire unit assembly must be seismically attached to the structure. This attachment and certification thereof shall be by this section.

TABLE A

"G" FORCES FOR VARIOUS CONDITIONS
(SEISMIC ZONE 2 - AV > 0.1 ≤ 0.2

PIPE AND DUCT	RIGIDLY MOUNTED EQUIPMENT	FLEXIBLY MOUNTED EQUIPMENT	ALL LIFE SAFETY
.25	.40	.40	.60

P. All vibration isolation and seismic devices described in this section shall be the product of a single manufacturer. Mason Industries shall be considered the Base Manufacturer of these specifications for the purposes of establishing a standard of equality; products of other manufacturers are acceptable provided their systems strictly comply with intent, structural design, performance and deflections of the Base Manufacturer.

Q. Seismic Restraint and Vibration Isolation Devices:
1. All isolation and seismic restraint devices shall be capable of accepting, without failure, the “G” forces as determined by the seismic certification and calculations as described in this section of the specifications.
2. Corrosion protection for outdoor applications shall be as follows:
   a. Springs cadmium plated, zinc electroplated or electrostatically deposited, baked enamel powder coated.

b. Hardware cadmium plated.
c. All other metal parts hot spray or hot dipped galvanized.

3. Seismic Restraint Types:
   a. All seismic restraint devices shall maintain the equipment in a captive position and shall not short circuit isolation devices during normal operating conditions.
   b. All seismic restraint devices shall have provisions for bolting and/or welding to the structure.
   c. Welding of springs to isolator housing and base plans is strictly prohibited.
   d. TYPE I: Spring Isolator – Restrained
      1) Spring shall have a minimum outer diameter to overall height ratio of 0.8:1 at rated deflection.
      2) Reserve deflection (from published load ratings to solid height) of 50% of the rated deflection.
      3) Ductile top cut with adjusting bolt tapped for equipment attachment locking cap screw.
      4) Minimum 1/4" thick neoprene acoustical base pad or cup on underside, unless designated otherwise.
      5) Integral restraining bolts with elastomeric cushions preventing metal-to-metal contact.
      6) Internal spring adjusting nut or bolt with leveling capability.
      7) Built-in all-directional limit stops with minimum 1/4" clearance under normal operation.
      8) Mountings shall have Anchorage Preapproval "R" number from California OSHPD, certifying the horizontal and vertical seismic load ratings.
      9) Cast or aluminum housings, (except ductile iron) are not acceptable.
         a) Mason Industries, Type SLR
   e. Type II: Where required, each corner or side of equipment base shall incorporate a seismic restraint snubber having an all directional resilient pad limit stop. Restraints shall be fabricated of plate, structural members or square metal tubing. Angle bumpers are not acceptable.
      1) Mason Industries Type Z-1225/Z-1011
   f. Type III: Restraints for suspended systems:
      1) Vibration isolated systems shall be braced with multiple 7 x 19 strand galvanized cable rope.
         a) Mason Industries Type SCB
      2) Non-isolated systems shall be braced with structural steel strut type with approved fastening devices to equipment and structure.
         a) Mason Industries Type SSB
      3) Steel angles (by HVAC Subcontractor) shall be provided to prevent rod bending of hung equipment where indicated by the Seismic Restraint vendor's submittals. Steel angles shall be attached to the rods with a minimum of three ductile iron clamps at each restraint location. Welding of support rods to angles is not acceptable. Rod clamp assemblies shall have Anchorage Preapproval "R" number from California OSHPD.

a) Mason Industries Model SRC

4) Pipe clevis cross braces are required at all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the clevis cross bolt. Clevis cross braces shall have Anchorage Preapproval "R" number from California OSHPD.

a) Mason Industries Model CCB

g. Type IV: Double deflection neoprene isolator encased in ductile iron or steel casing.

1) Mountings shall have Anchorage Preapproval "R" number from California OSHPD, certifying the horizontal and vertical seismic load ratings.

a) Mason Industries Type RC or BR

h. Type V: Rigid attachment to structure utilizing wedge type expansion anchors for bolting and steel plates, either cast-in or anchored with wedge type expansion bolts, for welding. Powder shots are not acceptable. Concrete anchor bolt spacing shall be in accordance with manufacturer's published standards.

4. Vibration Isolator Types:

a. Type A: Spring Isolator – Free Standing

1) Spring shall have a minimum outer diameter to overall height ratio of 0.8:1 at rated deflection.

2) Reserve deflection (from published load ratings to solid height) of 50% of the rated deflection.

3) Ductile top cut with adjusting bolt tapped for equipment attachment locking cap screw.

4) Minimum 1/4" thick neoprene acoustical base pad or cup on underside, unless designated otherwise.

a) Mason Industries Type SLF

b. Type B: Spring Isolator – Restrained

1) Spring shall have a minimum outer diameter to overall height ratio of 0.8:1 at rated deflection.

2) Reserve deflection (from published load ratings to hold height) of 50% of the rated deflection.

3) Ductile top cup with adjusting bolt tapped for equipment attachment locking cap screw.

4) Minimum 1/4" thick neoprene acoustical base pad or cup on underside, unless designated otherwise.

5) Integral restraining bolts with elastomeric cushions preventing metal-to-metal contact.

6) Internal spring adjusting nut or bolt with leveling capability.

7) Built-in all-directional limit stops with minimum 1/4" clearance under normal operation.

8) Mountings shall have Anchorage Preapproval "R" number from California OSHPD, certifying the horizontal and vertical seismic load ratings.

a) Mason Industries Type SLR, SSLFH

c. Type C: Spring Hanger Isolator

1) Spring shall have a minimum outer diameter to overall height ratio of 0.8:1 at rated deflection. Spring element shall have a steel upper spring retainer and a lower

elastomer retainer cup with an integral bushing to insulate lower support rod from the hanger box.

2) Reserve deflection (from published load ratings to solid height) of 50% of the rated deflection.

3) Steel hanger box shall be capable of 30 degree misalignment between the rod attachment to structure and the connection to the supported equipment. Hanger boxes shall withstand three times the rated load without failure.

a) Mason Industries Type 30

d. Type D: Double deflection neoprene isolator encased in ductile iron or steel casing.

1) Mountings shall have Anchorage Preapproval "R" number from California OSHPD, certifying the horizontal and vertical seismic load ratings.

a) Mason Industries Type RC or BR

e. Type E: Elastomer Hanger Isolator

1) Molded neoprene element with an integral bushing to insulate lower support rod from the hanger box.

2) Steel hanger box shall withstand three times the rated load without failure.

a) Mason Industries Type HD

f. Type F: Combination Spring/Elastomer Hanger Isolator

1) Spring and neoprene elements in a steel hanger box with the features as described for Type C and E isolators.

a) Mason Industries Type 30N

g. Type G: Pad type elastomer isolator

1) Neoprene pad shall have 0.75" minimum thickness, deflection rating of 0.1 inch under rated load. Supports shall be connected in the center by a 1/8" tear strip to facilitate trimming to desired size in two inch increments.

2) 1/16" galvanized steel plate between multiple pad layers.

3) Load distribution plate where attachment to equipment bearing surface is less than 75% of the pad area.

4) When bolting is required for seismic compliance, neoprene and duck washers and bushings shall be provided to prevent short circuiting of bolt.

a) Mason Industries Type Super Waffle (SW) pad

h. Type H: Pad type elastomer isolator

1) Laminated canvas duck and neoprene maximum loading 1000 psi, minimum 1/2" thick.

2) Load distribution plate where attachment to equipment bearing surface is less than 75% of the pad area.

3) When bolting is required for seismic compliance, neoprene and duck washers and bushings shall be provided to prevent short circuiting.

a) Mason Industries Type HL Pad

i. Type I: Thrust Restraints

1) A spring element same as Type A shall be combined with steel angles, backup plates, threaded rod, washers and nuts to produce a pair of devices capable of limiting thrust movement of air moving equipment to 1/4".

2) Restraints shall be easily converted in the field from a

compression type to tension type.

3) Unit shall be factory pre-compressed.

a) Mason Industries Type WB

j. Type J: Telescoping Riser Guide

1) Telescoping arrangement of two sizes of steel tubing separated by a minimum 1/2" thickness of Type H pad.

a) Mason Industries Type VSG

k. Type K: Resilient Pipe Anchors and Guides

1) All directional acoustical pipe anchor, consisting of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2" thickness of Type H pad.

2) Vertical restraints shall be provided by a similar material arranged to prevent vertical travel in either direction.

3) Allowable loads on neoprene pad shall not exceed 500 PSI and the design shall be balanced for equal resistance in any direction.

a) Mason Industries Type ADA

l. Type M: Flashable restrained isolator

1) Shall have all features of Type B isolator.

2) Shall have waterproof spring covers for adjustment or removal of springs.

3) Unit shall have a structural top plate for welding or bolting of supplementary support steel.

4) Isolator shall accept 2" roofing insulation and be flashed directly into the waterproofing membrane.

5) To be complete with wood nailer and flashing.

a) Mason Industries Type RFS.

m. Type P: Elastomer Isolator

1) Double deflection neoprene compression mountings shall have all metal surfaces neoprene coated.

2) Non-skid top and bottom surfaces.

3) Threaded bolting sleeves shall be embedded in the isolator.

4) Drilled tie-down bolt holes shall be provided in the base plate.

a) Mason Industries Type ND

5. Equipment Bases:

a. All curbs and roof rails are to be bolted or welded to the building steel or anchored to the concrete deck to attain specified acceleration criteria and shall also be capable of resisting a minimum psf wind loads (non-simultaneous).

b. Type B-1: Integral Structural Steel Base:

1) Constructed of structural members to prevent base flexure at equipment startup and misalignment of driver and driven units. Perimeter members shall be a minimum of 1/10th the longest unsupported span.

2) Centrifugal fan bases shall be complete with motor slide rails and drilled for driver and driven units.

3) Height saving brackets shall be used to reduce operating height and maintain 1" operating clearance under base.

a) Mason Industries Type MSL, WFSL

c. Type B-2: Concrete Inertia Base

1) Steel concrete forms for floating foundations. Bases for pumps shall be large enough to support elbows and/or suction diffusers. The base depth shall be a minimum of 1/12 the longest unsupported span, but not less than 6" or greater than 12".
2) Forms shall include concrete reinforcement consisting of steel bars or angles welded in place on 8" centers both ways in a layer 1½" above the bottom.
3) Isolators may be set into pocket housings which are an integral part of the base construction or utilize height saving brackets set at the proper height to maintain 1" clearance below the base.
4) Base shall be furnished with steel templates to hold anchor bolt sleeves and anchors while concrete is being poured.
   a) Mason Industries Type KSL or BMK

d. Type B-3: Spring Roof Curb
1) Spring isolation curbs that bear directly on the roof support structure and are flashed and waterproofed into the roof's membrane waterproofing system. Equipment manufacturer's or field fabricated curbs shall not be used.
2) All spring locations shall have removable waterproof covers to allow for spring adjustment and/or removal. Disassembly of the weather and air seal to gain access to the isolators is not acceptable.
3) Springs shall have all of the features of Type B.
4) Curbs shall have continuous sheet metal sides and have provision for 2" insulation to be installed and furnished by the Roofing Contractor.
5) Waterproofing shall consist of a continuous galvanized flexible counter flashing nailed over the lower curb's waterproofing membrane and joined at the corners by EPDM bellows.
6) Wood nailer and flashing shall be provided.
7) Shall have a California OSHPD Seismic Anchorage Preapproval "R" number.
8) Shall include a means of incorporating a sound barrier package, supported from the top isolated rail consisting of two layers of waterproof gypsum board furnished and installed by the General Contractor.
9) Contractor shall have the option of ordering the curb built to the roof pitch or field leveled in accordance with all seismic provisions of this section.
10) Overhung condensing units (when applicable) shall be supported by Type B isolators and spanning (width) steel support angle. These isolators shall in turn be supported on a field built curb.
   a) Mason Industries Type RSC

e. Type B-4: Flashable Roof Rail System – Isolated
1) Continuous structural support rails that combine equipment support and isolation mounting into one unitized assembly.
2) Rails shall incorporate Type B springs which are adjustable, removable and interchangeable after

equipment has been installed.

3) The system shall maintain the same installed and operating height with or without the equipment load and shall be capable of being utilized as a blocking device.

4) The entire assembly shall be an integral part of the roof's membrane waterproofing.

5) Unit to be supplied with continuous upper and lower galvanized flashing.

a) Mason Industries Type RIR

f. Type B-5: Not Used.

g. Type B-6: Non-isolated roof curb

1) Same as B-3 without spring isolation.

a) Mason Industries Type URC

h. Type B-8: Non-isolated.

1) Same as continuous support rails, Type B-4 without the spring isolation.

a) Mason Industries Type RUR

i. Type B-9: Steel Rails

1) Steel members of sufficient strength to prevent equipment flexure during operation.

2) Height saving brackets to reduce operating height.

3) Rails shall be cross braced at support and equipment attachment points when used in seismic zones.

a) Mason Industries Type R, ICS

6. Flexible Connectors:

a. All connectors shall be installed on the equipment side of shutoff valves; horizontal and parallel to equipment shafts whenever possible. Piping shall be supported and/or anchored to resist pipe movement beyond the allowable movement of the flexible connector.

b. Installations must include check valves and/or other design and installation precautions to reduce the threat to life safety when subjected to the specified seismic accelerations.

c. Type FC-1: Spherical Elastomer Connector

1) Manufactured of peroxide cured EPDM in the covers, liners and polyester tire cord frictioning. Curing must take place in steel molds closed within heated hydraulic presses.

2) Solid steel rings shall be used within the raised faced rubber flanged ends to prevent pullout. Flexible cable bead wire is not acceptable.

3) Sizes 2" and larger shall have two spheres reinforced with a molded-in ductile iron external ring between spheres. Bolted-on strap type reinforcing are not acceptable.
Flanges shall be split ductile iron with hooked or similar interlocks. Sizes 16" to 24" may be single sphere.

4) Threaded one piece bolted flange assemblies with female threaded ends for sizes 3/4" to 1½".

5) Rated at 250 psi up to 170° F. with a uniform drop in allowable pressure to 170 psi at 250° F. for sizes through 14". 16" through 24" single sphere minimum ratings are 180 psi at 170° F and 130 psi at 250°F.

6) Factory tested at 150% of rated pressure for 12 minutes

before shipment. Safety factor to burst and flange pullout shall be a minimum of 3:1.

7) Concentric reducing expansion joints with equal ratings and features may be substituted.

8) Connectors shall be installed in piping gaps equal to the length of the connector under pressure.

9) Control rods are required in unanchored installations where the installation exceeds the pressure requirement without control rods.

a) Control rods shall have 1/2" thick neoprene washer bushings large enough in diameter to take the thrust at 1,000 psi maximum on the washer area.

10) Connectors bolted to Victaulic type coupling or gate, butterfly or check valves to have a minimum 5/8" flange spacer installed between the connector and the coupling flange. Connectors must mate to a flat faced flange in all instances.

a) Mason Industries SAFEFLEX Type SFU, SFEJ, SFDEJ or SFDCR

d. Type FC-2: Flexible Stainless Steel Hose

1) Stainless steel hose and braid rated with 3:1 safety factor.

2) 2" diameter and smaller with male nipples, 2½" and larger with fixed flat faced steel flanges.

3) Lengths shall be: 9" for 2½" through 4"; 11" for 5" and 6"; 12" for 8"; 13" for 10"; 14" for 12" through 16".

a) Mason Industries Type BSS

e. Type FC-3: Upbraided Exhaust Hose

1) Low pressure stainless steel annularly corrugated with one floating and one fixed flanged end.

2) Maximum temperature of 1500 degrees F.

a) Mason Industries Type SSE

f. Type FC-4: Flexible Bronze Braided Hose

1) Metal hose and braid rated with a minimum 3:1 safety factor. (Minimum 150 PSI)

2) Copper tube ends.

a) Mason Industries Type BBF

2.49 WATER FLOW MEASURING DEVICES

A. Flow meter fittings shall be installed as indicated on the drawings and in the following piping systems and locations for balancing and testing purposes:

1. Each chilled water, condenser water and hot water pump or common manifold for paralleled pumps with full stand by.
2. Each chilled water cooling coil.
3. At condenser water and chilled water piping to each chiller.

B. Venturi fittings for 3/4 inch through 2 inch flow fittings shall have NPT connections for threaded pipe and the 2½ inch through 10 inch flow fittings shall fit between a pair of pipe flanges with gaskets, nuts and special bolts. All flow fittings shall have "slide valve" enabling fitting to be used with portable flow meter, gauge, purge and drain attachment and cleaning attachment and when withdrawn shall automatically close the "slide valve".

C. Provide combination balancing valve and flow device where indicated on the drawings or specified. Flow device - valve assembly shall have ball valve construction of bronze, suitable for use as bubble-tight service valve, calibrated balance setting indicator plate, shrader valve connections with caps for meter hose connections. Units shall be Taco circuit setters.

2.50 WATER SYSTEM ACCESSORIES

A. Equipment shall be sized for the service indicated on the drawings. Equipment shall be as manufactured by Bell & Gossett, Armstrong, Taco, or Thrush.

B. Piping system air vents shall be provided with indicated on drawings and at high points of all hot water and chilled water piping sections. Vents shall be as manufactured by Bell & Gossett, Armstrong, Taco, or Thrush. Any vents not accessible shall be piped to an accessible location.
   1. Air vents, except where noted otherwise, shall be manual air vents suitable for 150 PSIG system pressure as manufactured by Bell & Gossett #4V coil-operated type.
   2. Air vent at the high point of each system shall be high capacity industrial automatic air vents of the float type with drain connection for water overflow as manufactured by Armstrong, Model #1-AV, B&G 107 or Spirax Sarco 13W.

C. Provide adjustable type water make-up pressure regulating valves for each water system indicated on the drawings and not noted to be furnished under Section 23 00 00. Valves shall be as manufactured by Bell & Gossett #6; Taco #335 or Thrush #21.
   1. Valves shall be suitable for minimum of 125 psi inlet pressure and shall be adjustable to the system pressure.
   2. Valves shall be provided with assemblies consisting of inlet pressure gauge, shut-off valves, inlet strainer, outlet pressure gauge and quick fill bypass with globe valves.

2.51 AUTOMATIC TEMPERATURE CONTROLS

A. General
   1. Furnish and install, as hereinafter specified, a native BACnet, Direct Digital Control (DDC), automatic temperature control system as manufactured by Trane, Delta, KMC, Alerton, Automated Logic Controls, or ENE.

   2. The DDC Contractor shall be fully licensed at the time of bid to do business in the job site area. The DDC Contractor must be either a wholly owned factory branch office or a fully licensed dealer of the manufacturer's listed above with a technical staff, complete spare parts inventory, and test and diagnostic equipment to keep systems in operation 24 hours per day, seven days per week. He shall have emergency service available in the local area for temperature control systems for which he is currently performing on-call emergency service 24 hours per day, seven days per week. Wholesale, distributor, or representative type ATC Contractors are unacceptable. This requirement will be strictly enforced.

B. Scope of Work

1. The ATC contractor shall furnish and install all equipment, accessories, and wiring required for a complete and functioning web based building management system.
2. The control system shall consist of, but not limited to all temperature controls as specified herein including all CPU's, DDCP's, CRT's, printers, sensors, software, thermostats, valves, actuators, dampers, damper operators, relays, control panels, and other accessory equipment and appurtenances, including electrical wiring, to fulfill the intent of the specifications and provide for a complete and operable system.
3. Provide actuators for equipment such as dampers where such actuators are not provided by the equipment manufacturers. Refer to floor plans for location and numbers of required actuators. Actuators shall be Belimo, or equal. Coordinate requirements with the HVAC subcontractor.
4. All materials and equipment used shall be standard components, regularly manufactured for this type of work and shall not be custom designed especially for this project. All components shall have been thoroughly tested and proven in actual use.
5. The Contractor shall furnish and install all control and interlock wiring for chillers, boilers, fuel oil, day tanks, alarms, and emergency generators unless specifically and clearly stated to be provided by others.
6. The ATC contractor shall review and study all HVAC drawings and the <u>entire specification</u> to familiarize themselves with the equipment and systems operation and to verify the quantities and types of dampers, operators, alarms, and bells he has to provide. Numerous references to the ATC contractor are made throughout this specification identifying work to be performed under the HVAC section in addition to work specifically indicated under this paragraph. It will be assumed that, if no specific inquiries are made during the bidding period, the HVAC/ATC subcontractors have reviewed all requirements and interfaces between equipment and controls, to result in a complete, integrated and fully operational HVAC system.
7. The Automatic Temperature Control Contractor shall provide one (1) copy of the BMS software.
8. The automatic temperature control contractor shall furnish and install power meters. Meters shall be networked into the building management system and shall provide point mapping of all available data to the new workstations. Meters shall be manufactured by Veris Model H8206. Exact location and installation of meters shall be coordinated with electrical sub-contractor.

C. Work by Others

1. Automatic temperature control valves, duct humidifiers and separable wells for immersion elements furnished by the control manufacturer shall be installed by the HVAC sub-contractor under the ATC contractor's supervision.
2. Automatic dampers that are specified to be furnished by the ATC contractor shall be installed by the HVAC subcontractor, under the ATC contractor's supervision.
3. Concrete foundations shall be provided by the general contractor. The HVAC sub-contractor shall furnish dimensional drawings to the general contractor.
4. All finished painting required for the temperature control piping and

equipment, shall be by the general contractor.

5. All cutting and patching necessary for the installation of the temperature control system, shall be by the HVAC sub-contractor.
6. Installation of duct smoke detectors shall be by the HVAC subcontractor, under the ATC contractor's supervision.

D. Submittals and Shop Drawings

1. Submit shop drawings and obtain written review comments before ordering or installing any equipment or material.
2. Submit shop drawings of all equipment. Shop drawings shall consist of but not limited to manufacturer's scaled drawings, valves and damper schedules, cuts and catalogs, including descriptive literature which shall indicate the construction, material, physical dimensions and complete operating data. All ATC shop drawings shall also contain a written description of the Sequence of Operations, enumerating and describing the function of each component.
3. Submit the following for approval:
   a. Control drawings with detailed wiring diagrams, network riser diagrams as well as bills of materials (with quantity of devices, ranges and voltages) and written sequences of operation, for each system type.
   b. Valve and damper schedules showing sizes, configurations, capacities, pressure drops and locations of equipment. Include type and quantities of actuators.
   c. Data sheets for control system components.
   d. Complete software information including names of software packages provided, control sequences performed, complete information on user programmability (commands, language details, and programming sequences), and detailed printouts of the actual software within each DDCP including user definable comment statements inserted throughout the program to guide a novice operator through the various sequences of the actual program.
   e. Graphics samples in full color clearly indicating level of detail to be provided on this project.
   e. Calculations for valve coefficients (CVs).
   f. Operators user's manuals.
   g. Complete point-to-point check-out procedures to ensure that all physical points are consistently tested and verified for this project.

E. Equipment Operation Instruction and Maintenance Manuals

1. On completion and acceptance of the work, furnish for approval three copies of written instructions on the proper operation and maintenance of all equipment and apparatus furnished under this section.
2. Each manual shall be provided with an index sheet listing the contents in alphabetical order and shall contain but not limited to the following material:
   a. Updated copies of all submittal data and shop drawings as specified previously.
   b. Manufacturer's instructions regarding the installation, maintenance and calibration of each component used in the ATC system installed by the ATC contractor.
   c. Copies of all warranties and guarantees issued by each equipment manufacturer.
   d. "As-built" interconnecting wiring diagrams and wire lists of the field

installed system with complete, properly identified numbering of each system component and device.

e. A set of "User's Manual" detailing the operation of the Building Management and Control System (BMCS). The manual shall describe the hardware operation as well as provide instructions in computer access and programming. This manual shall be submitted under separate cover. The User Manual shall be written for an inexperienced user. It shall describe in layman's language, the functions and procedures of "using" the system.

F. Acceptance Testing

1. At substantial completion of the work, the ATC contractor shall prepare a punch list of all items remaining to be completed or corrected. The failure to include any items on such list does not alter the responsibility of the ATC contractor to complete all work in accordance with the contract documents. This list shall be delivered to the engineer prior to the ATC contractor's request for formal acceptance testing.
2. Additionally, the ATC contractor shall provide an equipment list and point list to the engineer prior to formal acceptance testing. Each material item and point must be initialed by the installing DDC technician that the item has been physically inspected for proper installation, functionality, and database entry.

   The verification form shall be similar to the following:

DDC Floor	Point Cabinet #	Point Name	Point Type	Point Address	Sensor On/Off	Oper. Reading	Test Initials	Test Time	Date

3. The engineer will prepare a list of items to be corrected or completed that shall include the punch list items identified by the ATC contractor, and any additional items found to be incomplete or incorrect. All items on both lists shall be completed or corrected before acceptance testing may proceed. The ATC contractor shall notify the engineer when he is ready to proceed with the acceptance test that system is complete and operates as required by the contract documents.
4. Acceptance Test Procedure:
   a. The ATC contractor shall demonstrate and verify in writing in the presence of the Engineer that all functions of the ATC and BMCS systems are operating as specified in the contract documents, including any required change orders. The final checkout will include, but not be limited to, the following items:
      1) Verification of the location, calibration and proper wiring/connection of all BMCS input and output devices.
      2) l BMCS software and output functions shall be tested individually.
      3) The proper operation and calibration of all ATC devices and actuators shall be verified individually.
      4) When system performance is deemed satisfactory by the Architect, system parts shall be accepted for beneficial use. Warranty shall begin. All minor deficiencies found will be noted in writing by the Engineer. All deficiencies so noted shall be corrected by the ATC contractor before the final acceptance will be issued.
      5) The ATC contractor shall allow sufficient time to complete

the acceptance test procedure.

b. Acceptance testing shall be coordinated with the Commissioning Agent. Refer to specification section 01 91 10 for additional requirements.

G. Training/Owner's Instruction

1. The ATC contractor shall provide three copies of an operator's user's manual describing all operating and routine maintenance service procedures to be used with the system as specified previously. The ATC contractor shall instruct the Owner's designated representatives in these procedures during the start-up and test period. The duration of the instruction period shall be no less than 40 hours and shall take place at the site. The training sessions shall be delineated such that at least 16 hours of training occur after the completion of system testing and balancing and commissioning. This training shall include instruction in the use and operation of the point editor function and graphics.
2. Training sessions shall be coordinated with the Commissioning Agent. Refer to specification section 01 91 10 for additional requirements.

H. Warranty

1. The ATC contractor shall guarantee the control system free from defects in material and workmanship and guarantee performance of the systems as required by the contract documents for one year of normal use and service beginning on the date the Owner has accepted the system.
2. The ATC contractor shall through the warrantee period, schedule visits to the site in order to provide two seasonal system review sessions with the building operators. The intent is for system review to take place at the time of seasonal system changeover. The contractor shall establish diagnostic trend logs on the OWS for the purposes of evaluating all major systems in the building, and a sample of terminal systems. Following any calibrations and adjustments the logs shall be submitted to the Architect for review.

I. Products

1. The Building Management and Control System (BMCS) shall consist of Network Level 1 controllers and Level 2 DDC controllers to monitor and control equipment per the control sequences. Level 1 controllers shall provide overall system coordination, accept control programs, perform automated DDC and energy management functions, control peripheral devices and perform all necessary mathematical functions. The controller shall be a microcomputer of modular design. The word size shall be 16 bits or larger, with a memory cycle time of less than 1 microsecond. Level 1 controllers will share information with and from the entire network of Level 1 and Level 2 controllers for full global control. Level 1 controllers shall permit multiuser operation from workstations and laptop computers connected either locally or over the Level 1 network. Level 2 controllers, also referred to as local control units shall provide intelligent, stand-alone control of HVAC, lighting equipment, and access control. Each unit shall have its own internal RAM memory and will continue to operate all local control functions in the event of a failure to any Level 1 controller. In addition, it shall be able to share information with and from the entire network for full global control.

J. Communications Processing

1. The BMCS shall operate as a true token-pass peer-to-peer communication network. Resident processors in each Multi-purpose controllers shall provide for full exchange of system data between other Multi-purpose controllers on the high performance peer to peer communications network. Systems that limit data exchange to a defined number of system points are not acceptable.
2. Systems that operate via polled response or other types of protocols that rely on a central processor or similar device to manage interpanel communications may be considered only if a similar device is provided as a stand-by. Upon a failure or malfunction of the primary device, the stand-by shall automatically, without any operator intervention, assume all BMCS network management activities.
3. The failure of any Multi-purpose controller on the network shall not affect the operation of other Multi-purpose controllers. A panel failure shall be annunciated at the specified graphical workstation, alarm printers, or operator terminals.

K. Color Graphic Workstation (located in Custodians Office).

1. The operator workstation will be furnished by the automatic temperature control contractor. The workstation shall consist of the latest generation of PC and shall operate at speed commensurate with the requirements of the ATC graphics and trending requirements. The ATC contractor shall furnish the PC with a dedicated UPS.
2. Network Connection: Graphical workstations shall allow for access to the BMCS network through a pull-down menu approach using only a mouse or similar point device. The keyboard shall be required only when entering text or for programming functions.
   a. The workstation shall be used as an interface to the BMCS network and shall not be required to process any control or energy management algorithms nor manage any BMCS network communications.
3. Graphical Software
   a. Software Description - workstation functions will include monitoring and programming of Level 1 and Level 2 controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments. The workstation software must be able to communicate to all Level 1 and Level 2 controllers, and where necessary integrate information that is common to one or more controllers. It shall be possible to program off-line from any Level 1 or Level 2 controller.

      The software will be oriented towards operators and programmers. In the operator's mode, all information will be available in graphic or text displays. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system.

      All operator functions shall be selectable through a mouse. A "windows" environment shall be used to allow multiple functions to be displayed on the screen simultaneously.

b. Operating System - The software will utilize the latest generation of Microsoft Windows.

c. Network Communications - The network consists of a high speed LAN comprised of Level 1 controllers, workstations and a file server. The file server acts as the central database for the workstations, so that all additions or changes made by one operator are immediately available to other operators on the network.

d. System Database - The workstation database shall consist of all points and programs in each of the controllers that have been assigned to the network. In addition, the database will contain all workstation files including graphic slides, alarm reports, text reports, historical data logs, schedules, and polling records. The software shall conform to the following:

1) Utilize Microsoft's SQL database server.

2) Whenever a new controller is added to the system, the software will automatically update that controller with its assigned points and programs. The system will also be able to verify that the point database in each controller is identical to the one at the workstation. If any discrepancy is found, it will automatically modify its database or notify an operator of the error.

3) The database shall also contain host level points consisting of variables which can be used for host level reports and alarming. These variables can be setpoints or the result of any boolean algebra expression.

4) Object Tree - It shall possible for an operator view the entire database through a graphical object tree display. This tree will present all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure.

e. System Configuration - Configuration of the database shall be through application modules, each having a unique "icon" for easy visual identification. Each module will provide a windowed menu in which to enter the required data base information. System configuration shall have the following features:

1) Each site, whether local or remote, shall have a separate record for storing pertinent communication parameters.

2) Controllers will be associated with a specific site file. The controller record will also contain the controller passwords and communication logon and logoff text strings.

3) Point records will include as a minimum a 32 character point description, engineering units, logging parameters, point status, and point value.

4) All database records will be available to the user at all times, regardless of the current tasks being performed by the workstation.

f. Color Graphic Displays - The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics.

These graphics shall contain point information from the database including any attributes associated with the point (engineering units). In addition operators shall be able to command equipment or change set points from a graphic through the use of the mouse. Requirements of the color graphic subsystem include:

1) SVGA, bit-mapped displays. The user shall have the ability to import CAD-generated picture files in the OS/2 Metafile format as background displays. Updates to imported CAD drawings will not affect workstation added animation.
2) A library of built in stencils, symbols and display shapes common to the HVAC industry.
3) An online graphics drawing editor that provides for all standard geometric shapes, multiple line thicknesses, shading, up to 16 colors, cutting and pasting of objects, inclusion of text, and zooming.
4) Built-in control panel objects such as buttons, knobs, gauges, and line graphs to enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels.
5) Status changes or alarm conditions can be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.
6) Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators will be able to move from one graphic to another by selecting an object with a mouse, no menus will be required.
7) The graphic system shall allow for one touch modification of any analog or digital point in the database regardless of its location in the network.

g. Automatic Monitoring - The software shall allow for the collection of data and reports from any Level 1 or Level 2 controller through either a hardwire or modem communication link. The time schedules and content of the polling shall be user configurable and include any subset of the controller's data base including application programs.

h. Alarm Management - The software shall be capable of both accepting alarms directly from Level 1 controllers, or generating alarms based on polling of data in controllers and comparing to limits or conditional equations configured in the host software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, reports, or initiating communication to another controller or remote computing device. Alarm management features shall include:

1) A minimum of 255 alarm levels. Each alarm level will establish a unique set of parameters for controlling alarm display, acknowledgment, keyboard

annunciation, alarm printout and record keeping.

2) When an alarm occurs the Alarm counter will be incremented by one.

3) Printout of the alarm or alarm report to an alarm printer or report printer.

4) Print the alarm acknowledgment or Return to Normal message.

5) Sound an audible beep on alarm initiation or acknowledgment.

6) It shall be possible to direct alarm displays to all or any of 16 groups of workstations on the network. Each configured path can be assigned on a unique basis to individual alarm levels.

i. Report Generation - The software will contain a built-in report generator, featuring word processing tools for the creation of custom building reports.

1) Reports can be of any length and contain any points with the database of Level 1 and Level 2 controllers.

2) The report generator will have access to the user programming language in order to perform mathematical calculations inside the body of the report, control the display output of the report, or prompt the user for additional information needed by the report.

3) It shall be possible to run other executable programs whenever a report is initiated.

4) Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.

j. Scheduling - It shall be possible to configure and download from the workstation schedules for any of the controllers on the network.

1) Time of day schedules shall be in a calendar style configured for either monthly or weekly operation. Scheduling shall be programmable up to one year in advance.

2) Each schedule will appear on the screen as a monthly calendar correctly showing the day, weekday, month and year. It shall be possible to scroll from one month to the next and view or alter any of the schedule times.

3) Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.

4) It shall be possible to configure multiple Holiday schedules in a yearly format. Holiday schedules will override the standard operating schedule for those days that have been defined as holidays. Holidays shall be differentiated on the calendar through color coding of the date. Any changes to a holiday schedule will be automatically updated to the standard schedule to which it has been superimposed.

5) There shall also be a provision for Special Day schedules. Special Day schedules will override both the standard schedule and its associated Holiday schedule. Special

Days will be differentiated on the calendar through color - coding of the date. Any changes to a Special Day schedule will be automatically updated to the standard schedule to which it has been superimposed.

6) The use of Holiday or Special Day schedules is strictly optional. Standard schedules do not require either of these two types of schedules.

7) The Scheduling application shall include built-in editing tools to permit users to copy and paste portions of schedules to different days, weeks or months. Users can select from a particular day, a range of days, or a nonconsecutive group of days over which to edit a schedule.

k. Programmer's Environment - the programmer's environment will include access to a superset of the same programming language supported in the Level 1 controllers. Here the programmer will be able to configure application software off-line (if desired) for custom program development, write global control programs, system reports, wide area networking data collection routines, and custom alarm management software.

l. Security

1) The software shall employ a two tiered password system. The first tier shall consist of the user's name. The second tier shall be a unique password consisting of up to 8 alphanumeric characters.

2) Each password shall have a unique access level. At least 8 levels will be defined as follows:

- ◊ No Access - View only graphics as presented in the log-in program.
- ◊ View Only - View all applications, but perform no database modifications.
- ◊ Acknowledge Alarms - View Only privileges plus the ability to acknowledge alarms.
- ◊ Change Values - View and Control point information, Acknowledge Alarms and modify Time Schedules.
- ◊ Enable / Disable - Change Value level plus allow the enabling or disabling of points and alarms.
- ◊ Configure - Minimal program level functions including creating and editing any object.
- ◊ Program - All privileges except password and create users
- ◊ Administrative - All privileges.

m. Saving/Reloading Programs

1) The workstation software shall have an application to save and restore field controller memory dumps. The site and device record files shall serve as a menu tree to coordinate save/reload records. Each record shall have a minimum 12 character record name and a 32-character description.

2) The Save/Reload application shall have the capability to set the system clock in a Level 1 controller.

3) Default values store in the workstation database shall be

sent to the controller during a reload operation either automatically or at the user's option.

4) If during a poll of a controller, the workstation determines that the controller program has been lost, it shall be possible for the workstation to automatically reload the program without operator involvement.

a) The software shall provide, as a minimum, the following functionality:
- Graphical viewing and control of environment
- Scheduling and override of building operations
- Collection and analysis of historical data
- Definition and construction of dynamic color graphics
- Editing, programming, storage and downloading of controller database.

b) The graphical interface shall allow for all system operations and applications to be quickly and easily selected using the mouse in conjunction with groups of drop-down menus, lists, graphics and icons. Provide functionality such that all operations can also be performed using the keyboard as a backup interface device. Provide additional capability that allows at least ten (10) special function keys to perform often-used operations.

c) Software shall provide for a windowed approach which supports concurrent viewing and commanding of system operations. The software shall provide a multi-tasking environment that allows the user to run several applications simultaneously. The mouse shall be used to quickly select and switch between multiple applications. This shall be accomplished through the use of Microsoft Windows or similar industry standard software that supports concurrent viewing and controlling of systems operations. The software shall be capable of simultaneously displaying and performing a minimum of two of the functions listed below in any workstation:

(1) Dynamic color graphics and graphic control
(2) Alarm reporting and acknowledging
(3) Time-of-day scheduling
(4) Trend data definition and presentation
(5) Graphic definition
(6) Graphic construction

d) Graphic displays shall be high-resolution, multi-colored presentations of actual building data and parameters.

Graphic displays may be quickly and easily viewed via any or all of the following methods as a minimum:

- Graphic links
- Drop down menus
- Special functions keys for points in alarm

(1) Graphic links shall be standard symbols which can be located on graphic displays as desired by the user. These links shall allow the user to view any graphic display, either in a hierarchical fashion or as otherwise defined. The quantity of possible links shall be limited only by the space available on each display.

(2) Drop-down menus may be used to view graphic displays by selecting from customized lists which include all graphics available for viewing. Provide the capability to quickly scroll through all lists.

e) Special function keys shall be used to quickly view graphic alarm displays and user-defined default graphics, such as campus or building site plans. From the alarm display, the user may quickly view the graphic on which the associated point in alarm resides.

f) Provide static and dynamic graphic display capabilities. Static displays such as site plans, building layouts, floor plans and schematics shall provide the user with maps to allow for quick and easy access to any building information. Dynamic graphic displays may represent any real-time system information. Any system point or group of points may reside on a dynamic display. Dynamic displays such as schematics of any mechanical system or piece of equipment shall allow the user to monitor and control actual building operating parameters. Point values such as temperature, humidity and flow, and point status such as on/off, normal and alarm shall automatically and continually update to indicate current operating conditions. As a minimum, symbols, text and colors shall be dynamic in nature.

g) Provide functionality to allow for any analog point value to be displayed as an individual dynamic display window
for use as a convenient control and diagnostic tool. The display window shall include the following information as a minimum:

- Point name
- Point description
- Setpoint
- Current value
- Range of values
- High and low limit setpoints

(1) All values shall be displayed in both text

and symbolic form, such as an analog bar, gauge or other standard measurement device. Setpoint values shall be changed by simply moving a pointer to the desired setting on the measurement device. After user verification of the correct setting the system shall control at the new setpoint. Provide the capability to superimpose these displays on their associated schematic graphics or on separate displays in user-defined groups.

h) Provide the capability to control any point from a dynamic graphic display. Relevant point information windows may be accessed by pointing to a symbol or text. Setpoints may be changed by simply entering the new value. Status may be changed by selecting from predefined lists. The display shall ask the user to verify the change before allowing the system to respond.

i) Provide alarm annunciation capabilities, such that alarm status shall be displayed automatically on the screen regardless of system operation or application modes. The quantity of current alarms shall be displayed via a flashing icon or similar symbol. In addition, provide an audible signal to indicate the occurrence of new alarms. An alarm window may be displayed to view the alarms. From the alarm window the user shall be able to view the graphic and display a customized message of at least 250 characters associated with the point in alarm. When the graphic id displayed, the symbol of the point in alarm shall be flashing and shall have changed color. The user shall also be able to acknowledge, respond to and clear selected alarm conditions as desired.

j) Provide a graphical spreadsheet-type format for simplification of time-of-day scheduling and overrides of building operations. Provide the following spreadsheet graphic types as a minimum:
- Weekly schedules
- Zone schedules
- Monthly calendars

(1) Weekly schedules shall be provided for each building zone or piece of equipment with a specific occupancy schedule. Each schedule shall include columns for each day of the week as well as holiday and special day columns for alternate scheduling on -user-defined days. Equipment scheduling shall be

accomplished by simply inserting occupancy and vacancy times into appropriate information blocks on the graphic. In addition, temporary overrides and associated times may be inserted into blocks for modified operating schedules. After overrides have been executed, the original schedule will automatically be restored.

(2) Zone schedules shall be provided for each building zone as previously described. Each schedule shall include all commandable points residing within the zone. Each point may have a unique schedule of operation relative to the zone's occupancy schedule, allowing for sequential starting and control of equipment within the zone. Scheduling and re-scheduling of points may be accomplished easily via the zone schedule graphic.

(3) Monthly calendars for a 24-month period shall be provided which allow for simplified scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the pointing device and shall automatically reschedule equipment operation as previously defined on the weekly schedules.

k) Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point (physical or calculated) may be trended automatically at predetermined time-based intervals or changes of value, both of which shall be user-definable. Trend data may be stored on hard disk for future diagnostics and reporting. Any point, regardless of physical location in the network, shall be collected and stored in each DDC controller's point group. Each DDC controller panel shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a minimum of 70,000 samples.

(1) Trend data report graphics shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or pre-defined groups of at least six points. Provide additional functionality to allow any trended data to be transferred easily to an off-the-shelf spreadsheet package

such as Lotus 1-2-3 or Microsoft Excel. This shall allow the user to perform custom calculations such as energy usage, equipment efficiency and energy costs and shall allow for generation of these reports on high-quality plots, graphs and charts.

(2) A collection schedule function shall be provided to automatically collect trend data. A menu shall prompt for days of the week and time of day for collection of selected points. Provide a minimum of 12 user-selected time schedules per day.

l) Provide additional functionality that allows the user to view trended data on trend graph displays. Displays shall be actual plots of both static and real-time dynamic point data. Up to four points may be viewed simultaneously on a single graph, with color selection and line type for each point being user-definable. Displays shall include an "X" axis indicating elapsed time and a "Y" axis indicating a range scale in engineering units for each point. The "Y" axis may be manually or automatically scaled at the user's option. Different ranges for each point may be used with minimum and maximum values listed at the bottom and top of the "Y" axis. All "Y" axis data shall be color-coded to match the line color for the corresponding point.

(1) Static graphics shall represent actual point data that has been trended and stored on disk. Exact point value may be viewed on a data window by pointing or scrolling to the place of interest along the graph. Provide capability to print any graph on the system printer for use as a building management and diagnostics tool.

(2) Dynamic graphs shall represent real-time point data. Any point or group of points may be graphed, regardless of whether they have been predefined for trending. The graphs shall continuously update point values. At any time the user may redefine sampling times or range scales for any profit. In addition, the user may pause the graph and take "snapshots" of screens to be stored on the PC disk for future recall and analysis. As with static graphs, exact point values may be viewed and the graphs may be printed.

m) A full screen, forms based point editor and programming function shall allow for point additions,

deletions, changes, program modification and creation and point and program storage. This program shall be similar to a word-processing format such that full documentation of program changes may be available. This program shall provide the user with the capability to insert full English narratives to describe the control program. Search, insert, find, cut and paste functions shall allow for quick program modifications.

n) Provide a general purpose graphics package such as PC Paint Plus “In-a-Vision” which shall allow the user to quickly and easily define or construct color graphic displays. In addition, provide a library of standard HVAC equipment and symbols such as Rooftop air handling units, chillers, cooling towers and boilers and standard electrical symbols that shall aid the user in definition of standard or custom graphics. Additional libraries of standard symbols may be easily added to the package or the user can define or construct symbols as desired for additional customization. Graphic displays may be defined or created to represent any building parameter, mechanical system or group of system points as described to facilitate building operation and analysis.

(1) Provide the user with the capability to easily define all system operating parameters.

(2) Libraries of standard application modules such as temperature, humidity and static pressure control may be used as “building blocks” in defining or creating new control sequences.

(3) The user shall have the capability to easily create and archive new modules and control sequences as desired via a word processing type format.

(4) Provide a library of standard forms to facilitate definition of point characteristics. Forms shall be self-prompting and incorporate a fill-in-the-blank approach for definition of all parameters.

(5) The system shall immediately detect an improper entry and automatically display an error message explaining the nature of the mistake.

o) Provide the capability to backup and store all system databases on the PC hard disk. In addition, all database changes may be performed while the PC is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate multi-purpose control units. Similarly,

changes made at the multi-purpose control units shall be automatically uploaded to the PC, ensuring system continuity. The user shall also have the option to selectively download changes as desired.

(1) The workstation shall provide for automatic upload and download of program changes. Any program change made at the workstation shall be downloaded to the respective multi-purpose control unit. Any program change made at the multi-purpose control unit shall be uploaded to the workstation disk.

(2) Should a multi-purpose control unit lose its RAM database, the workstation shall automatically download that control unit's program from the hard disk.

(3) An auto-boot function shall allow an unattended workstation to automatically re-start from a power failure.

p) Provide context-sensitive help menus to provide instructions appropriate with operations and applications currently being performed.

q) Multiple user security levels shall be provided to allow for various degrees of system access and control. Provide a minimum of four levels of access, with each increasing level allowing control of additional system operations and applications. A minimum of twelve unique passwords, including user initials, shall be provided. The system shall automatically generate a report of log-on/log-off time and system activity for each user. Provide automatic log-off capability to prevent unauthorized system use. Automatic log-off time shall be user-definable in one-minute increments and may be disabled if desired.

r) The workstation shall be provided with a key element display that **records** logos, log-offs, TOD overrides, alarms and alarm acknowledgments. Provide a 500 element circular buffer for recording purposes. Key element reports may be filtered by operator name and may be run for a user defined time interval.

n. All points mapped to the workstation shall be available in both text and graphic format. All operator functions available on the text side of the workstation must also be available on the graphics side.

L. Multi-Purpose Controllers

1. Provide multi-purpose DDC controllers. Each multi-purpose controller shall be a microprocessor-based direct digital control unit and shall be capable of operating as a standalone controller on a high performance peer to peer

network. Provide each multi-purpose controller with sufficient memory to operate in a truly independent manner; that is, each controller shall support its own inputs and outputs, operating system, database and programs necessary to perform control sequences and energy management routines. Additionally, each multi-purpose controller shall have sufficient memory to support the application specific controllers and LAN control panels connected to it over the local area networks.

2. Each multi-purpose controller shall be capable of full operation either as a completely independent unit or as a part of the building-wide control system. All units shall contain the necessary equipment for direct interface to the sensors and actuators connected to it.
3. Control strategies shall be owner definable at each multi-purpose controller, and for all control units in the system from any one operator terminal. Each control unit shall provide the ability to support its own operator terminal if so desired.
4. Each multi-purpose controller shall include its own microcomputer direct digital controller, power supply, input/output modules, and battery. The battery shall be self-charging and be capable of supporting all memory within the control unit if the commercial power to the unit is interrupted or lost for a minimum of 100 hours. Upon a power failure at the remote unit, operator intervention shall not be required to maintain the database.

M. Networking Communications

1. General - the network architecture shall consist of two levels. The top level shall be a high speed Ethernet LAN designed to support network controllers, central plant controllers, work stations and a file server. The second level shall be a RS485 Token passing bus to support a family of dedicated local controllers for control of HVAC equipment, lighting, and access control. The second level bus shall communicate bidirectionally with the high speed LAN through Level 1 controllers for transmission of global data.
2. High Speed LAN - this Ethernet local area network shall operate at a minimum speed of 10 Mb/sec utilizing a TCP/IP communications architecture. The high speed LAN will provide transfer of point data, alarms and file activity among Level 1 controllers, work stations and the file server. The high speed LAN shall support a minimum of 50 nodes consisting of Level 1 controllers or workstations.

   Any data from a Level 2 controller can also be transmitted onto this bus through a Level 1 controller. The high speed LAN shall support multi-user communications and multi-session activity. That is, all global data sharing shall occur simultaneously with the transmission of alarm data or user activity.
3. Field Bus - the level 2 bus, or field bus, supports local control units of modular size for operation of the building's HVAC, lighting and access control systems. This RS485 bus shall operate at a minimum speed of 19200 baud, with a minimum length

   of 4000 feet or 32 nodes before requiring a network repeater. A minimum of 127 Level 2 controllers shall be configureable on the field bus. Manufacturers with baud rates of less than 19200 shall be limited to 64 Level 2 controllers to insure adequate global data and alarm response times.

   The field bus shall permit peer to peer communications among all Level 2 controllers and allow simultaneous communications with laptop computers

that are connected to a Level 2 controller. Failure of the Level 1 controller will not impair the operation of its associated field bus.

4. Network Transparency - all points contained on Level 1 and Level 2 controllers shall be considered global points. Any program in any controller on the network shall be able to reference any point in any controller regardless of its location on the network.
5. Workstation Communications - workstations shall be connected directly to the high speed LAN. Workstations shall be able to communicate to any Level 1 controller, Level 2 controller, to additional workstations or the file server. Work stations shall also be able to communicate via modems to remote controllers via a RS232 connection. Telephone communications shall operate simultaneously with communication to any controllers connected on the high speed LAN.
6. Laptop Communications - the laptop computer shall communicate with either Level 1 or Level 2 controllers. Through the laptop, operators shall be able to view points and change parameters on any Level 1 or Level 2 controller on the network.
7. Dial-up Communications - it shall be possible to access the network remotely through a standard dial-up modem. This modem shall permit direct access to the high speed LAN via a Level 1 controller. It shall be possible to configure multiple modems in Level 1 controllers to enable multi-user communications when more than 1 telephone line is available.

N. DDC Controllers:

1. A Level 1 controller has its own on-board CPU, clock/calendar, EPROM, RAM, ROM, communication port(s), and network connections to the high speed LAN and the field bus. The Level 1 controller may either have on-board or remote mounted I/O. Level 1 controllers are capable of complete standalone operation. Level 1 controllers are available with an optional user display.

   The firmware shall consist of the operating system, communication software, programming language, and resident control application software. The firmware may optionally contain user interface software to support dumb terminal operation. Where this is not provided the Level 1 controller must be optionally programmable from the laptop computer.

   The custom application software shall reside in battery backed RAM or EPROM. RAM will also be used for storing trend data and clock/calendar information.

   Level 1 controllers shall provide communication to both the high speed LAN and the field bus. In addition, a minimum of 1 RS232 or RS485 port shall be provided for connection to a workstation or laptop computer. When the port is RS232, it shall optionally support communication to a modem or printer. Where multiple RS232 ports are available, multi-user communications shall be supported.
2. Analog Inputs - the Analog Input (AI) function shall monitor each analog input, perform A/D conversion, and hold the digital value in a buffer for interrogation. The A/D conversion shall have a minimum resolution 12 bits. Input ranges shall be within the range of 0-10 VDC or 4 - 20 mA.
3. Digital Inputs - the Digital Input (DI) function shall accept dry contact closures and voltage level transitions. A voltage level below 1 volt shall be read as ON (closed), a voltage level above 3 volts shall be read as OFF (open).

4. Pulse Accumulator Inputs - the pulse accumulator input function shall have the same characteristics as the DI, except that, in addition a buffer shall be included to totalize pulses between interrogations. Each input shall accept pulses at a minimum of 2 per second.
5. Temperature Inputs - temperature inputs originating from a thermistor, shall be monitored and buffered as an AI, and provide automatic conversion to degrees F or C without any additional signal conditioning.
6. Input Wiring - all inputs shall be two wire devices and shall not require shielded wire for accurate operation.
7. Outputs - output types shall include digital, universal and tri-state. Outputs shall be available with built-in hand-off-auto switches for local overrides.
8. Digital Output - the Digital Output (DO) function shall provide contact closure for momentary (Pulse Width Modulation) and maintained operation of field devices. Output pulse width shall be selectable between 0.1 and 3200 seconds with a minimum resolution of 0.1 seconds. Isolation and protection against voltage surges up to 180 VAC peak shall be provided. Contact rating shall be a minimum of 1 amps at 24 VAC. Each digital output shall be equipped with an optional ON/OFF/AUTO switch to manually obtain either output state. Manual overrides shall be reported to the controller at each update. An LED shall be provided to indicate the state of each digital output.
9. Universal Output - a Universal Output shall provide 0-20VDC, 0-20 mA control signal (with a maximum resolution of .1 volt and .1 mA), and standard Form C relay operation (1 amps, 24 VAC). It shall be possible to select the mode of output operation for each output by simply wiring to the appropriate terminations
   on the controller. No circuit boards or output cards shall have to be exchanged to select the desired output mode.
10. A three-position manual override switch shall allow selection of the ON, OFF, or AUTO output state. In addition each UO shall be equipped with an override potentiometer to allow manual adjustment of the analog
    output signal over its full range, when the 3 position manual override switch is placed in the ON position.
11. The Form C output mode shall be capable of standard digital output operation including pulse width modulation.
12. All current outputs shall be fuse protected to 120VAC.
13. Tri-State Outputs - tri-state outputs shall consist of two 24VAC relays for control of bi-directional motors and actuators. Each tri-state output is capable of PWM (pulse width modulation) to a resolution of .1 second.

O. DDC Controller Resident Software Features
1. General:
   a. All necessary software to form a complete operating system as described in this specification shall be provided.
   b. The software programs specified in this Section shall be provided as an integral part of DDC Controllers and shall not be dependent upon any higher level computer for execution.
2. Control Software Description:
   a. Software Description - The application software shall be configured for each Level 1 controller either locally through a laptop computer or through a workstation. Level 1 controllers shall contain PROM as the resident operating system. Application software will be RAM

resident. Application software will only be limited by the amount of RAM memory. There will be no restrictions placed on the type of application programs in the system.

Each Level 1 controller shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function by Level 1 controllers shall not be interrupted due to normal user communications including; interrogation, program entry, printout of the program for storage.

b. Real-Time Operating System - Provide a real time operating system in PROM memory requiring no operator interaction to initiate and commence operations. The program shall include:
   1) Operation and management of all devices.
   2) Error detection and recovery from arithmetic and logical faults
   3) Editing software to allow the user to develop or alter application programs.
   4) System self-testing
   5) Multi-user.
   6) Multi-tasking.

c. Editor - When programming a controller through either a dumb terminal or laptop computer, editing and word processing features will include as a minimum:
   1) Cut, copy, paste, and undo.
   2) Search and replace.
   3) Comments.
   4) Scrolling.
   5) Character, line, and page cursor control.

   When programming in terminal mode, the system will allow full screen, character editing for correction or modification of any portion of a program. Syntax errors will be highlighted, and programmers must make corrections prior to the program being compiled. When programming Level 2 controllers, the programming environment will be identical to Level 1 programming with automatic uploading and downloading of the compiled code to the controller.

d. Point Identification - Users must be able to assign unique identifiers for each connected point. Identifiers must have at least twelve alpha/numeric characters. All references to these points in programs, reports, and command messages shall be by these identifiers.

   Each point name can have up to a 40 character description, and optionally engineering units (up to 8 characters).

e. User Programming Language - The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be English language and programmable by the user.

   The language shall be structured to allow for the easy configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations,

passwords, and histories.

The language shall allow the creation of timers anywhere in the logic of a program. Each timer shall increment in seconds and increment to a maximum of 365 days.

The language shall be self-documenting. Users shall be able to place comments anywhere in the body of a program. Program listings shall be configurable by the user in logical groupings.

f. Application Software - The system shall contain include ROM based, built-in software modules for the creation of standard application programs. Modules will include as a minimum:
   1) PID Algorithm
   2) Self-tuning PID
   3) Calendar Functions (Seconds, minutes, hour, day of week, day of month, day of year, month and year)
   4) Curve fit
   5) Optimum Start

g. Mathematical Functions - Each controller shall be capable of performing basic mathematical functions (+,-,X,/), squares, square roots, exponential, logarithms, boolean logic statements, or combinations of both.

   The controllers shall be capable of performing complex logical statements including operators such as >,<,=, and/or,exclusive. These must be able to be used in the same equations with the mathematical operators and nested up to five parenthesis deep.

h. Passwords - Level 1 controllers will have up to 8 levels of passwords. The highest level will allow access to all functions within the system. The remaining 4 levels will be definable by the user to include any subset of system commands.

i. History Logging - Each controller shall be capable of logging any system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system variables (inputs, outputs, math calculations, and flags) can be logged in history. A maximum of 32767 values can be store in each log. Each log can will record either the instantaneous, average, minimum or maximum value of the point. Logs can be automatic or manual.

   If shall be possible to find the average of a log, the standard deviation, the sum, minimum or maximum. It shall also be possible to reference any value within a log for use in a control program.

j. Reporting - The system shall be able to create user definable reports containing any combination of text and system variables. Report templates will be created by users in a word processing environment. Reports can be displayed based on any logical condition or through a user command.

   Numerical displays shall be up to 10 digits in length, with up to 4 digits to the right of the decimal point. The format of each numerical display shall be user definable.

k. Alarming - For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms will be tested each scan and can result in the display of one or more alarm messages or reports. Messages and reports can be sent to the optional display panel, a local terminal, to the Host Computer, via modem to a remote computing device.

l. Debugging Tools - The language shall have built in program debugging tools for program simulation and error detection.
When a control program is placed in a debug mode, a continuous record shall be kept of the last 128 steps before discarding the oldest data. Up to 4 control programs can be placed in a debug mode concurrently.

m. Overriding Programs - It shall be possible to disable any point in the system and modify it to a user definable value. Any points that have been disabled will be kept in a log and viewable by an operator at any time.

P. Control Valves

1. All automatic valves shall be fully proportioning with packing glands designated for hot or chilled water service. All valve bodies shall be designated for 125 psig service and shall have bronze trim and throttling plug inner valves for modulating control. Valves shall be normally open or closed as required and each shall be sized for the allowable pressure drop.
2. All two-way valves shall have external spring adjustment with a self-sealing V-ring packing arranged to tighten the seal as the water pressure increases so that no manual adjustment is necessary.
3. All other heating coil valves shall be either normally open or closed as specified. The interiors of all such valves shall be designed for 100% tight shut-off against the operating pressure.
4. All automatic valves and separable sockets shall be furnished by the Temperature Control Contractor and installed in the lines by the Mechanical Contractor.

Q. Dampers

1. All automatic dampers shall be furnished by this Contractor. Automatic control dampers shall be Ruskin CD60 or approved equal. All dampers for modulating control shall be of the proportioning type with adjacent louvers rotating in opposite directions. Damper frames shall be constructed of 16 gauge galvanized sheet metal. Bearings shall be nylon with oil impregnated sintered iron bushings. All linkages shall be fastened to blades within the damper. Provide double linkages on damper panels over 42” wide.
2. Replaceable rubber seals shall be provided with the dampers. Seals shall be installed along the top, bottom and sides of the frames and along each blade. Seals shall provide a tight closing, low leakage damper. Leakage and floor characteristics charters shall be submitted to the architect prior to approval of dampers.
3. Electronic Actuator
   a. Actuators for damper control shall be direct coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp assembly shall be of a “V” bolt design with associated “V” shaped toothed cradle attaching to the shaft for maximum strength eliminating slippages. Spring return actuators shall have a “V” clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05 inches when the damper is constructed in this manner. Single bolt or set screw type fasteners are not acceptable.
   b. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the

entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.

c. For power failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable.

d. All spring return actuators shall be capable of both clockwise or counterclockwise spring return operation by simply changing the mounting orientation.

e. Actuators shall be Belimo, or equal.

4. All of the automatic dampers shall be furnished by the Temperature Control Contractor and installed by the Sheetmetal Subcontractor.

5. Combination smoke/fire control dampers amperage draw of motor shall be provided by temperature control contractor. Dampers shall meet UL555S leakage class 2 standards and shall be equipped with wall sleeves and factory mounted electric actuators. Dampers shall be Ruskin S050 or approved equal.

R. Electronic Sensors

1. All mixed air and coil discharge sensors shall utilize industry standard thermistor with averaging elements. Sensing elements shall be a minimum of 25 ft. and temperature sensed shall be averaged over the entire length of the element.

2. Space type sensors shall have an accuracy of +/-.5 degrees over sensed temperature range (20/120F).

3. Well type sensors used for liquid immersion shall have stainless steel removable wells. Sensing element shall have an accuracy of +/- .5 degrees over amperage draw of motor the range (70/220F or 20/120F) of the sensor. Each sensor shall have a suitable electrical box to enclose all wiring connections.

4. Temperature control wells shall be installed by mechanical contractor under supervision of temperature control contractor.

S. Smoke Detectors

1. The Electrical Sub-Contractor shall furnish smoke detectors to be installed in ductwork by the Sheetmetal Subcontractor. The Electrical Sub-Contractor shall wire from the detectors to the associated HVAC unit control circuit for shutdown of fans. The Electrical Sub-Contractor shall wire the normally closed contacts in series to the fan starter holding coil. All wiring to smoke detectors shall be by the Electrical Sub-Contractor.

2. All units shall utilize smoke detectors, as specified.

T. Safety Low Limit Thermostats

1. All fan systems introducing outdoor air with hot water coils shall be equipped with safety low limit thermostats designed to stop the fan while closing the outdoor air damper any time the discharge temperature falls below 38 degrees. The safety thermostats shall utilize a 20 foot sensing element responsive to the lowest temperature along its entire length. Provide one thermostat for each 16 square foot coil surface as a minimum.

U. Current Sensors

1. Current sensors shall be analog type, sensitivity dated for the application with a 4-20 ma or 0-10 Vdc output. Span and sensitivity shall be adjustable. Sensors shall be used for all fans and pumps.

V. Air Static Pressure Transmitter

1. Transmitter shall have range of 0-1" or 0.5" w.g. and send a 4-20 milliamp output signal. Zero set range and span set range +/- 5% of full range output. A combined static error (non-linearity, non-repeatability, and hysteresis) +/- .5% of full range output. Transmitter ranges shall be selected by ATC contractor as appropriate for intended use.

W. Water Differential Pressure Transmitter

1. Low differential pressure transducer for wet-wet application. 4-20 milliamp output signal. Setra C230 or equal.

X. Building Management and Control System Wiring

1. All input and output control wiring to the control units shall be #18 twisted and shielded cable. All shield to be grounded at the control panel, shields at the sensors or transducers to be folded back and taped.
2. Communication trunk wiring shall be #18 twisted and shielded cable. Trunk isolator/extenders shall be installed on either end of trunk.
3. All cable splices shall have joints soldered and taped including the shield. No mechanical connections will be acceptable.
4. No digital input or output points shall be more than 250 feet from its respective panel.
5. All wiring within the panels must be made with connectors of appropriate size and design for the terminals being applied.
6. All connections within the panels must be made with connectors of appropriate size and design for the terminals being applied.
7. All cables must be labeled and identified on corresponding termination drawings. A copy of the termination drawing will be adequately protected and left in its respective panel.

Y. Control Wiring

1. Electrical work will be in accordance with NFPA 70, ANSI C2 and Division 26 of these specifications. Electrical wiring, terminal blocks and other high voltage contacts will be fully enclosed and marked to prevent accidental injury.
2. All wiring associated with the installation will be the responsibility of the Contractor. The term "wiring" is construed to include furnishing of wire, conduit, miscellaneous material and labor to install a total working system.
3. It is the responsibility of the Electrical Sub-Contractor to provide adequate connections and extensions from 120 volt power sources to the various items of equipment requiring power under this contract. <u>Branch circuits serving equipment under this contract will be separate and used only for such equipment</u>. All branch circuit conductors 120 volts or greater will be at least 14 gauge copper, type THW, 600 volt insulation, installed in minimum 3/4 inch conduit (EMT).
4. Transient Protection - All electronic equipment including processors, relays, monitoring devices, temperature sensors and other non-computerized solid state equipment will be adequately protected against power line transients or RFI interference. Equipment that fails to operate properly due to transient or other electrical interference, in the opinion of the Engineer, will be required to be retrofitted with the appropriate protection device(s).

Z. Points List: (the following points list is the minimum required points that will be available to all user interface devices)

1. Boilers:
   a. Boiler enable/disable.
   b. Boiler status.
   c. Boiler sequencing.
   d. Boiler firing rate.
   e. Boiler isolation control valves.
   f. Hot water supply temp.
   g. Hot water return temp.
   h. Boiler failure alarms.
   i. Hot water reset control.
2. Boiler pumps:
   a. Pump status.
   b. Lead/lag control.
   c. Differential pressure sensors.
   d. Variable frequency drives % command.
   e. Pump failure alarms.
3. Chillers:
   a. Chiller enable/disable.
   b. Chiller status.
   c. Chilled water supply temp.
   d. Chilled water return temp.
   e. Chiller failure alarms.
   f. Chiller connected load in tons.
   g. Chilled water reset control.
   h. Minimum evaporator chilled water flow control.
   i. Evaporator heater.
4. Chilled water pumps:
   a. Pump status
   b. Pump lead/lag control.
   c. Differential pressure sensors.
   d. Variable frequency drives % command.
   e. Pump failure alarms.
5. Rooftop Energy Recovery Units (ERU):
   a. Unit enable/disable.
   b. Supply fan status.
   c. Supply fan VFD % command.
   d. Return fan status.
   e. Return fan VFD % command.
   f. Discharge air temp. set point (winter)
   g. Discharge air temp. set point (summer)
   h. Discharge static pressure.
   i. Discharge air humidity.
   j. Return air temp.
   k. Return air humidity.
   l. Recirculation air damper command.
   m. Filter status.
   n. Occupied set point.
   o. Unoccupied set point.
   p. Freezestat.
   q. Return air CO2 monitoring (where applicable).

r. Hot water valve command/position.
s. Chilled water valve command/position.
t. Outside air entering temperature. (DB/WB)
u. Supply air temp. leaving enthalpy wheel. (DB/WB)
v. Supply air temp. leaving chilled water coil. (DB/WB)
w. Supply air temp. leaving heat pipe. (DB/WB)
x. Exhaust air temp. leaving heat pipe. (DB/WB)
y. Exhaust air temp. leaving enthalpy wheel. (DB/WB)

6. Rooftop air handling units (RTU):
   a. Supply fan status.
   b. Supply fan enable/disable.
   c. Supply fan VFD % command.
   d. Return fan status.
   e. Return fan enable/disable.
   f. Return fan VFD % command.
   g. Discharge air temp.
   h. Discharge static pressure.
   i. Discharge air humidity.
   j. Supply air CFM.
   k. Supply air temperature reset.
   l. Return air temp.
   m. Return air humidity.
   n. Return air CFM.
   o. Mixed air temp.
   p. Mixed air damper command.
   q. Outside air CFM.
   r. Outside air minimum CFM set point.
   s. Filter status.
   t. Return air CO2 monitoring (where applicable).
   u. Room occupancy sensor (where applicable).
   v. Hot water valve command/position.
   w. Compressor staging.
7. Air Handling Units (AHU):
   a. Supply fan status.
   b. Supply fan enable/disable.
   c. Supply fan VFD % reference/command
   d. Discharge air temp.
   e. Discharge static pressure.
   f. Discharge air humidity.
   g. Supply air CFM.
   h. Supply air temperature reset.
   i. Mixed air temp.
   j. Outside air CFM.
   k. Outside air minimum CFM set point.
   l. Filter status.
   m. Return air CO2 monitoring (where applicable).
   n. Room occupancy sensor (where applicable).
   o. Hot water valve command/position.
   p. Chilled water valve command/position (where applicable).
8. Kitchen Make-up Air Unit:
   a. Unit enable/disable.
   b. Fan status.

c. Fan enable/disable.
d. Fan Speed Control.
e. Unoccupied set point.
f. Kitchen hood exhaust fan interlock.
g. Return air and outside air damper position command.
h. Gas furnace staging command.

9. Fancoil Units:
   a. Room temperature.
   b. Room temperature set point.
   c. Occupied set point.
   d. Unoccupied set point.
   e. Chilled/hot water valve command/position.
10. Exhaust Fans:
   a. Exhaust fan enable/disable.
   b. Exhaust fan status.
11. Unit heaters/Cabinet unit heaters:
   a. Room temperature.
   b. Room set point.
   c. Heating valve command.
12. Fintube Radiation and Convectors:
   a. Room temp.
   b. Room set point.
   c. Heating valve command.
13. Radiant Panels:
   a. Room temp.
   b. Room set point.
   c. Heating valve command.
14. Hot Water Heater
   a. Setpoint temperature.
   b. Operational status (on/off)
15. Acid Neutralization System
   a. System failure alarm.
   b. High Level Alarm.
16. IDF/MDF Ductless Split Fancoil Units
   a. High temperature alarm.
   b. DFC failure alarm.
17. Global Points:
   a. Outdoor air temp. (DB/WB)
   b. Outdoor air humidity. (Rh)

AA. Hard Wired Alarms
1. The following hard wired alarms shall be provided by the ATC sub-contractor, which shall include a relay output (through a contact closure) and wiring to the MDF room with 30’ coiled and labeled at the backer board for connection to the system:
   a. Boiler failure alarm.
   b. Building low temperature alarm.

2.52 SCAFFOLDING AND STAGING

A. General: Filed Subcontractors shall obtain required permits for, and provide scaffolds, staging, and other similar raised platforms, required to access their

Work as specified in Section 01 50 00 - TEMPORARY FACILITIES AND CONTROLS and herein.

B. Scaffolding and staging required for use by this Filed Subcontractor pursuant to requirements of Section 01 50 00 - TEMPORARY FACILITIES AND CONTROLS shall be furnished, erected, maintained in a safe condition, and dismantled when no longer required, by this Filed Sub-Trade requiring such scaffolding.

C. Each Filed Subcontractor is responsible to provide, maintain and remove at dismantling, all tarpaulins and similar protective measures necessary to cover scaffolding for inclement weather conditions other than those required to be provided, maintained and removed by the General Contractor pursuant to MGL (Refer to Section 01 50 00 - TEMPORARY FACILITIES AND CONTROLS and as additionally required for dust control).

D. Furnishing portable ladders and mobile platforms of all required heights, which may be necessary to perform the work of this trade, are the responsibility this Filed Subcontractor.

2.53 HOISTING MACHINERY AND EQUIPMENT

A. All hoisting equipment, rigging equipment, crane services and lift machinery required for the work by this Filed Subcontractor shall be furnished, installed, operated and maintained in safe conditions by this Filed Subcontractor, as referenced under Section 01 50 00 - TEMPORARY FACILITIES AND CONTROLS.

PART 3 EXECUTION

3.1 MATERIALS AND WORKMANSHIP

A. All materials installed in this work shall be new, unless noted for re-use, without damaged functional or aesthetic components. All equipment finished shall be touched up with matching finishes where slight scratches occur. Equipment or material subject to severe deterioration shall be completely refinished or replaced as directed by the Architect.

B. All labor utilized in the installation of work shall be experienced in the respective trade required. The installation of exposed finished materials shall be neatly done flush, straight and/or plumb, without distortion, meeting the building finished surfaces.

C. All HVAC materials and equipment shall conform to the Standards listed within this Section of the Specifications and wherever such standards have been established, items shall bear its respective label.

D. Where labor to be furnished must meet specific Code requirements, only individuals certified to do such shall be used.

E. All equipment shall be installed in accordance with the manufacturer's instructions and recommendations with adequate clearance for access for maintenance.

3.2 COORDINATION

A. This Contractor shall give full cooperation to other trades and to the General Contractor and shall furnish any information necessary to permit the work of all trades to be installed satisfactorily and with least possible interference or delay. If this Contractor installs his work before coordinating with other trades, he shall make the necessary changes in his work to correct the condition, without extra charge. In areas, if due to construction conditions, more than one trade is required to use common openings in beams, or conduits, this Contractor must plan and locate the positions of the items of piping, ducts, and conduits, which are under the scope of his Contract with that of items under the scope of other Contractors, in order that all items are properly located and may be accommodated within the space available. Location and positioning shall be done prior to installation and to the satisfaction of the Architect and/or Engineer.

B. This Contractor shall obtain detailed printed information from the manufacturer of equipment which he is to provide for the proper methods of installation. He shall also obtain all information from the General Contractor and other Contractors which may be necessary to facilitate his work and the completion of the whole project. All equipment shall be installed in strict accordance with manufacturer's recommendations.

C. The work to be accomplished under this Section includes work within existing areas adjacent to the site of new construction. Continuity of services within existing areas shall be maintained. Any interruption of services necessary to accomplish the work shall be made only with the consent of the General Contractor and at such time(s) as the Owner designates.

D. This Contractor shall not unnecessarily disturb or interfere with the Owner's use of the facilities associated with or adjacent to this Contract. When interference is necessary, permission shall be obtained from the General Contractor before any operation or service line is disturbed or disconnected.

E. This Contractor shall include under coordination work the installation of all systems in conformance with governing codes. This Contractor is advised that no piping, ducts or equipment foreign to the electrical equipment shall be permitted to be installed in, enter or pass through such spaces or rooms provided for switchboards and panelboards in accordance with Article 384 of the National Electrical Code.

F. Diffusers, grilles and registers located in the ceiling shall be located as shown on the Architectural Reflected Ceiling Plan and coordinated with ceiling grid, lights, and speakers. Items shown on the HVAC Drawings, but not located on the Reflected Ceiling Plan shall be coordinated to be located as indicated on the HVAC Drawings.

3.3 COORDINATION DRAWINGS

A. Coordination Drawings shall be initiated under this Section of the Specifications. It is this Contractor's responsibility for preparation of project Coordination Drawings showing the installation of all equipment, piping, ducts and accessories to be provided under this Section of the Specifications. These Drawings shall be prepared at not less than 3/8 inch = 1'0" scale and shall show building room layouts, structural elements, ceiling grid, diffusers, registers, grilles, ductwork and lighting layouts out of

function. A reproducible copy of each Drawing prepared shall then be submitted to each Contractor working under the Plumbing, Fire Protection and Electrical Sections of this Specification, who shall be responsible to coordinate their equipment and systems and shall show these on the Drawings submitted. After each Trade Contractor has fulfilled their obligations, they shall return the Drawings to the HVAC sub-contractor. After each Drawing has been coordinated between trades, each trade shall sign each Drawing indicating acceptance of the installation condition. This Contractor shall then print the coordination original, and these prints shall be submitted, through the General Contractor to the Architect, for review and comment, similar to Shop Drawings. Comments made on these Drawings shall result in a correction and resubmittal of the Drawings. A master small scale Drawing of the entire building shall be initially prepared showing all areas involved and the Drawing numbers covering each area.

3.4 PROTECTION AND CLEAN UP

A. This Contractor shall be responsible for maintenance and protection of all materials and equipment furnished by him during the construction period from loss, damage or deterioration until final acceptance by the Owner. All materials and equipment on the job site shall be stored and protected from the weather. All piping and equipment openings shall be temporarily closed during construction to prevent obstruction and damage.

B. All equipment with damaged finished surfaces shall be cleaned and repainted with the same paints as were factory applied.

C. Clean-Up: Keep the job site free from the accumulation of waste materials and rubbish daily. At completion of the work, remove all rubbish, construction equipment and surplus materials from the site and leave the premises in a clean condition

3.5 OPERATING AND MAINTENANCE MANUALS

A. This Contractor shall provide four (4) complete sets of operating and maintenance manuals to the Owner prior to the operating instruction period. Maintenance manuals shall be submitted for approval. The receipt of approved maintenance manuals by the Owner shall be a prerequisite to system acceptance. Each manual shall include the following:

1. A complete set of Shop Drawings arranged in accordance with their appearance in the Specifications. Drawings shall be folded and included in envelopes and bound into the manual.
2. A complete set of operational and servicing instructions for each piece of equipment, bound into the manual adjacent to the corresponding Shop Drawing.
3. A complete listing of all equipment suppliers, together with local agent's names, addresses and telephone numbers.
4. A complete set of valve listings.
5. Copies of all service contracts provided for the guarantee period.
6. Copies of all equipment and system warranties.

3.6 OPERATING INSTRUCTIONS

A. This Contractor shall provide competent representatives of his firm and also qualified representatives for his major equipment to instruct Owner-designated personnel on the start-up, operation, shut-down and servicing of all equipment and systems furnished and installed under this Section. No less than ten (10) days notice shall be given to the Owner for the beginning of the instruction period to permit scheduling of Owner personnel. The instruction period shall be a prerequisite to system acceptance. This contractor shall coordinate this requirement with the Commissioning Agent. Refer to specification section 01 91 10 for additional requirements.

B. Training of the Tenant's and Building Owner's operation and maintenance personnel is required in cooperation with the Tenant's and Building Owner's representatives. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Tenant's and Building Owner's Representatives after submission and approval of formal training plans. Refer to Commissioning Specifications, Section 01 91 13 for contractor training requirements.

C. At the conclusion of the operating instructions, this Contractor shall have the Owner's personnel sign-off stating they have received the required instruction. Separate statements shall be required for each piece of equipment and system. These statements shall include date, names of Owner's representative, name of instructor, and brief description of equipment or system.

3.7 SYSTEM START-UP AND OPERATION

A This Contractor shall provide all labor and materials and services necessary for the initial start-up and operation of all systems and equipment furnished and installed under this Section of the Specifications.

B This Contractor shall provide the services of qualified factory representatives for all major equipment pre-start set-up, start-up and initial operation. Such periods shall be sufficient to insure proper operation of systems and equipment.

C This Contractor shall check all equipment during the initial start-up to insure correct rotation, proper lubrication, adequate fluid flows, non-overloading electrical characteristics, proper alignment and minimal vibration. Systems shall be checked for air and/or steam and/or water flows throughout without blockages. Rooftop air handling units shall be checked for proper damper connections and positions aligned and adjusted belt drives, proper lubrication, temporary air filters installed, non-excessive electrical characteristics and minimal vibration. Miscellaneous equipment shall be started and operated as described above, as applicable. This Contractor shall prepare and submit monthly start-up and status reports for all equipment and systems as indicated on the schedules. Initial form of this report shall be submitted for review with the initial submittals. Upon closing in of the structure or upon first equipment start-up, the report filing shall be started. One copy of this report shall be submitted to the Testing and Balancing Contractor for his record purposes. Submittal of these reports is a prerequisite for processing and evaluating requisitions.

1. Contractors' tests shall be scheduled and documented in accordance with the commissioning requirements. Refer to Commissioning Specifications, Section 01 91 13 for additional requirements.
2. System verification testing is part f the commissioning process. Verification testing shall be performed by the contractor and witnessed and documented by the Commissioning Agent. Refer to Commissioning Specification Section 01 91 13 for system verification tests and commissioning requirements.

D During operation of systems, qualified licensed personnel shall be provided and designated for maintenance of the equipment and systems in good running order. Items such as strainer cleanout, bearing lubrication, packing replacement and other consumables shall be provided without cost to the Owner. Failure of equipment during this period due to lack of proper supervision is the responsibility of this Contractor, and continued failures shall be grounds for the Owner to provide such services with back-charges to this Contractor.

E. Prior to building flush out, all filters installed within all air handling equipment shall be replaced with filters having minimum rating of MERV 13 unless such equipment was specified with filters having a higher rating. Air handling equipment shall include but not be limited to air handling units, rooftop units, energy recovery units, make-up air units, fancoil units and classroom unit ventilators. Upon completion of building flush out, all filters installed within all air handling equipment shall be replaced with filters having minimum rating of MERV 13 unless such equipment was specified with filters having a higher rating.

F. Coordinate all start-up, operation, and testing activities with the Project Manager, General Contractor and the Commissioning Agent per specification section 019110.

3.8 SYSTEMS IDENTIFICATION

A. General:
1. All equipment, ductwork and piping furnished under this Section shall be marked for ease of identification in accordance with ANSI A13.1-1981 Standard or as indicated below by this Contractor.
2. Marking shall be done using painted stenciling applied to clean, smooth surfaces.
3. Lettering type and size shall be in accordance with paragraph 3.4 and Table 3 of ANSI Standard, with sharply contrasted background for ease of identification. Duct labeling shall not be less than 3 inches in height. Colors shall be in accordance with paragraph 3.2 and Table 2 of the ANSI Standard.

B. Equipment:
1. Equipment markings shall be prominently painted on each normally visible side of equipment. Equipment intended for installation in finished areas shall have markings located behind normally used access panels mounted so as to be readily found.
2. Equipment identification designations shall be taken from equipment schedules as indicated on the Drawings.
3. All rooftop air handling units, energy recovery units and make-up air units shall be numbered on at least two (2) sides in 4" to 6" letters of contrasting color. Number shall be associated with the street or occupancy address

preceding the HVAC unit number (example, 23-1, 23-2, etc.). LED or keyed remote test switch shall be labeled with device number information corresponding to rooftop designation. Where rooftop units with duct smoke detectors are above a suspended ceiling, the tile grid shall be marked with a red dot if an LED is not present.

C. Piping:

1. Piping marking, except as noted below, shall be prominently painted on all piping concealed and exposed to view, at entries to shafts and at all valving. Marking spacing shall be every 20 feet and at all changes in direction.
2. Piping markings shall indicate direction of flow with piping designation taken from piping legend indicated on Drawings.
3. In lieu of painting pipe marking for outside diameters of no less than 3/4 inches but less than 6 inches labeling shall be on semi-rigid plastic which shall be wrapped entirely around the item being identified and attached to itself to form a non-removable band.
4. In lieu of painting pipe marking for outside diameters of 6 inches or greater, springs or metal bands secured to the corners at each end of the semi-rigid plastic marker so as to hold each end of the marker firmly against the pipe may be utilized.
5. In lieu of painting, for outside diameters less than 3/4 inches, labeling of 1/2 inch high lettering on 1-1/2 inch minimum diameter tags shall be attached so as direction of flow arrows will indicate proper flow direction when tag is being read.

D. Ductwork:

1. Ductwork marking shall be prominently painted on all ductwork concealed and exposed to view. Marking spacing shall be every 20 feet at all dampers and at all changes in direction.
2. Ductwork marking shall indicate direction of air flow with ductwork designation to consist of the equipment designation to which it is connected and indicate either high or low velocity system.
3. Access doors at service openings for fire dampers, smoke dampers and smoke detectors shall be identified with letters no less than 1/2 inch in height to indicate the location of the fire protection device(s) within.

E. Valve Tags:

1. Valve tags shall be 1-1/2 inch diameter brass with 1/4 inch high lettering for service designation over 1/2 inch high valve number designation and shall be provided for all valving.
2. Two (2) sets of valve lists shall be prepared showing tag numbers, valve locations and valve service. Valve tag numbers shall be marked on Record Drawings. One valve list shall be prepared based on sequenced room numbers of valve locations; one valve list shall be prepared based on valve numbers. One set of lists shall be framed under glass and duplicate list laminated between plastic sheets.
3. One (1) additional copy shall be framed under glass and mounted on the wall in location as designated by the Architect.

3.9 SHEET METAL WORK REQUIREMENTS

A. Furnish and install all sheet metal work as herein specified for all air handling systems shown on drawings and/or described in the specifications.

B. All sheet metal work shall be done in a neat and workmanlike manner with ductwork following building lines and in straight lines with smooth transitions and offsets as required to suit actual installation. Sheet metal work which does not conform to drawings and/or specifications or is poorly done shall be repaired and/or replaced as described by the Architect.

C. Reference shall be made to the paragraph covering Coordination Drawings for the responsibility in the preparation of same.

D. Sheet Metal Contractor shall include in his work furnishing and installing volume dampers in accordance with SMACNA requirements; additional dampers in the duct system for the purpose of balancing by the Balancing Contractor, as well as dampers shown on the drawings.

E. Sheet Metal Contractor include in his work furnishing and installing automatic control, fire, smoke and combination fire/smoke dampers.

F. Air handling systems shall conform to the following:
   1. All sheet metal work required for ductwork casing and plenums of all low pressure air handling systems shall be galvanized steel and shall conform to requirements of sheet metal work. Exceptions to this requirement shall be as specifically listed below or as indicated on the drawings.
   2. All sheet metal work required for ductwork, casings and plenums of air handling system with scheduled total static pressure equal to or greater than 3 inches shall conform to the requirements for the static pressure scheduled. This construction shall apply from the outside air and return air dampers at the unit inlet and extend to the system terminal boxes.
   3. Sheet metal supply and return ductwork for the surgery areas from the terminal boxes to the supply diffuser (including plenum) and from the exhaust registers for 10 feet shall be aluminum.
   4. Sheet metal exhaust ductwork for lab exhaust and all other fumehoods shall be 316 stainless steel. All joints and seams shall be welded to provide a continuous seal.

G. All casings and plenums shall be provided with 54 inch high, 20 inch wide access doors, except where larger door is required for equipment replacement, or when casing or plenum will not accommodate this size door. When alternate door of larger size is required, it shall be sized to meet requirements of equipment being served. For doors smaller than 54” x 20” the largest following door size which can be accommodated shall be provided: 48” x 20”; 36” x 18”; 24” x 18”; 18” x 18”; 18” x 12”; or 12” x 22”. In all cases the bottom of the door opening shall be a minimum of 6 inches above the plenum’s bottom.

H. Two-piece streamliner shall be furnished and installed at no additional cost to the Owner around each conduit, beam or other obstruction passing through ductwork. Obstructions in ductwork shall be allowed only when offsets around ducts are not possible and shall be indicated on Coordination Drawing.

I. Sealants: All seams in sheet metal work shall be permanently sealed airtight by the use of appropriate mastic compounds. Joints between dissimilar materials shall be provided with lead gaskets. Louver plenums shall be provided with lead gaskets. Louver plenums shall have all bottom seams and side seams up to distance of 12 inches sealed using solder.

J. Duct Liners: Where ducts indicated on drawings or specified are to be lined, such lining shall conform to the requirements specified under Acoustic Liner indicated in Paragraph “Sheet Metal Work”. Duct sizes indicated on the drawings are nominal internal dimensions and therefore shall be increased accordingly to accommodate duct lining.

K. The Sheet Metal Contractor shall install all duct mounted smoke detectors, heat detectors and other devices furnished by the Electrical Sub-Contractor for mounting in the ductwork or air handling equipment.

L. Fire dampers shall be installed in accordance with the manufacturer's installation instructions. Fire dampers shall be capable of maintaining the integrity of the required fire-resistance rating and shall be accessible. Where ductwork is rearranged to facilitate coordination or installation, the fire dampers shall be provided at locations where air distribution systems penetrate assemblies required to have a fire-resistance rating.

1. Exception when approved by the Architect and Engineer are as follows:
2. When proper fire tests have shown that fire dampers are not necessary to maintain the integrity of the fire-resistance rated assembly.
3. Sub-ducts extending 22 inches vertically upward may be used in lieu of fire dampers for exhaust ducts penetrating a fire-resistance rated shaft wall.
4. Penetrations of tenant separation and corridor walls in buildings equipped throughout with an approved automatic fire suppression system.
5. When the ducts are constructed of steel and are part of an engineered smoke removal system.
6. Penetrations of corridor walls when the ducts are constructed of steel and do not have openings which communicate the corridor with adjacent spaces or rooms.
7. Penetrations of a roof assembly when ducts are open to the atmosphere.
8. Hazardous exhaust systems as defined in the Mechanical Code.

M. All prefabricated duct sections shall be cleaned prior to storage on the site and be provided with protective covering on all openings to maintain the interior of the ductwork clean and free of dust and other materials prior to installation. Field assembled duct sections shall be cleaned during assembly and similarly protected until installation.

N. Blank off all portions of louvered openings not required for ventilation systems.

O. Access doors shall be provided adjacent to each fire damper, smoke damper, combination fire/smoke damper, and smoke detector. The access opening shall be large enough to permit inspection, maintenance and resetting of the device. Where the size of the duct permits, the minimum size door should be 18 inches x 16 inches.

P. Testing for ductwork shall be performed for all duct systems specified to be constructed to a static pressure class of 4” w.g. or greater and to all stainless steel

exhaust systems serving laboratory hoods or other systems designed to convey hazardous fumes or materials. The leakage class shall be in accordance with Table 4-1 of SMACNA HVAC Air Duct Leakage Test Manual, First Edition 1985.

Q. The Sheet Metal Contractor shall install automatic control dampers furnished by the Automatic Temperature Control System manufacturer and shall include all safing and/or duct transitions to complete damper installation.

3.10 PIPING SYSTEM INSTALLATION

A. Installation of Pipe, Fittings and Valves:

1. Furnish and install piping approximately as indicated; straight, plumb and as direct as possible; form right angles on parallel lines with building walls.
2. Keep pipes close to walls, partitions and ceilings; offset only where necessary to follow walls, as indicated.
3. Locate groups of pipes parallel to each other; space them at distances to permit applying full insulation and to permit access for servicing valves.
4. Piping shall be accurately cut to measurements established in the field and worked into place without springing or forcing. All piping shall be assembled using standard manufacturer's screwed or welded fittings. Where standard fittings are not available for branch connections, use "Threadolets" or "Weldolets" as appropriate to suit pipe sizes, neatly cut and welded into the line.
5. All piping shall be reamed to be free of burrs.
6. Keep pipe free from scale and dirt; protect open pipe ends whenever work is suspended during construction to prevent foreign bodies entering and lodging there. Use temporary plug or other approved material for protection.
7. Use all long radius ells on welded piping.
8. Provide bypass line with globe valve with isolation valves to provide bypass around all control valves which serve air handler coils and other central system equipment. Bypass valves are not required for terminal units, radiation, fancoils, cabinet heaters, unit heaters and similar equipment served from a central system. Bypass valve size shall be a minimum of one-half the supply line size.
9. Prior to installation of any piping, submit shop drawings indicating location of all pipes larger than 2 inches in diameter. Piping may be shown on Coordination Drawings in lieu of shop drawings.
10. Provide cap and chain for 3/4 inch hose connection for all drain valves.

B. Installation for Chilled Water and Hot Water Systems:

1. Pitch all piping in direction of flow.
2. Automatic vent valves shall be installed in the piping systems, where indicated on the drawings at all high points of any piping system.
3. Drain valves shall be located at the base of all low points in the piping systems and at all water connections to associated equipment and pumps. Drain valves shall be 3/4 inch gate valves with 3/4 inch drain hose threaded adapters.
4. Provide blow-down line with ball valve on each strainer with cap and chain.
5. Provide pressure relief valve and piping to allow bypass of discharge from each pump back to pump inlet where pump shut off head exceeds the maximum rated working pressure of any pipe segment, fitting, valve, or other device. Relief valve shall be sized to recirculate adequate flow to

maintain system pressure below the rated working pressure. When provided, the bypass piping shall be connected between the pump and isolation valves.

C. DX Systems:
1. Charging of refrigerant piping shall be done subsequent to pressure testing.
2. Evacuate system to 2.5 mm of mercury and hold vacuum for eight (8) hours and then break vacuum with dry nitrogen. Re-evacuate piping to 2.5 mm and break vacuum with refrigerant charge.
3. Pipe sizing, where indicated on drawings, are the sizes estimated for specific manufacturer's equipment and anticipated piping installation.
   a. The Contractor shall provide piping sized for actual piping installation requirements for the field installation conditions in accordance with the system equipment manufacturer's recommendations.
4. All refrigerant systems which require field piping shall include a filter-dryer, moisture indicator, liquid line sightglass, refrigerant charging connections and solenoid valves. Devices not furnished with the refrigeration equipment shall be provided by this Contractor.

D. Installation of Unions:
1. Provide unions, screwed or flanged, in the following locations:
   a. In long runs of piping to permit convenient disassembly for alterations or repairs. Provide unions in all trench piping located every 20 feet and at all connections in branch and mains leaving the trench.
   b. In bypass around equipment.
   c. In connections to traps, tanks, pumps, and other equipment.

E. Installation of Valves:
1. Provide shut-off valves where indicated and in the following locations:
   a. Risers and main branches at points of take-off from their supply or return mains. Valves shall be arranged so that piping mains for the building and for each floor can remain in service while branch line piping is out of service. Balancing valves suitable for shut-off service shall be used in returned piping.
   b. Individual equipment, control valves, strainers, traps and other piping systems devices at inlet and outlet to permit unit removal for repairs without interfering with remainder of system.
2. Locate valves for easy access and operation.
3. Do not locate valves with stems below horizontal.
4. Provide balancing valve at outlet of each equipment connection. In water piping systems, locate balancing valve as shown on drawings where piping details are provided.

F. Pipe Welding: Welding backing rings shall be used at each pipe weld. All pipe welders shall be tested and qualified under the National Certified Pipe Welders Bureau. Welders for high pressure steam shall be certified for ASME Code welding.

G. Expansion:
5. Provide for taking up expansion in hot water, steam, condenser water and chilled water by means of loops, offsets, guides and anchors, where indicated and/or required.

6. Use swing or swivel joints for connections from mains to risers and from risers to radiators, unit heaters and other heating units; use at least five (5) fittings from main to riser, including tee in main; use at least four (4) fittings from riser to radiator or unit heater, including tee in riser.
7. When installing expansion loops, they may be cold sprung. Cold springing shall compensate for approximately half of the total expansion.

I. Drains: All coiling coils shall have drip pans, trapped and condensation discharge piped to nearest suitable receptor except as noted otherwise. All traps shall be located inside to prevent freezing. Trap seals shall be appropriate for respective units scheduled pressure differential plus 50 percent on coils downstream of fans, and a minimum 3 inches for coils upstream of fans.

I. Intake and exhaust plenums not detailed to have through-louver drainage shall have a 1 inch drain connection with a serviceable 3 inch deep trap provided within a heated space to prevent freezing and piped to the nearest floor drain or janitor sink. Bottom of plenum shall pitch toward drainage opening. Drain lines indicated on the drawings to terminate through the wall to outdoors shall not be required to include a trap.

3.11 PIPING SYSTEM FLUSHING AND CLEANING

A. This Contractor shall make temporary connections and required adjustments to the piping system for the purpose of cleaning and flushing.

B. Steam and return piping shall be blown out by operating steam with all returns run to waste until the system is thoroughly cleaned out. During the above period, all strainer and thermostatic trap interiors shall be removed and strainers and traps cleaned, together with dirt pockets. The system shall be left free from oil, scale and dirt. The strainer and trap interiors shall be replaced after the system has been cleaned.

C. Hot water and chilled water lines shall be chemically cleaned by circulating water solution for not less than four (4) hours, flushed out and cleaned with water run to waste. All strainers shall be removed, cleaned and replaced. All equipment such as pumps, coils and heat exchangers shall be checked to insure all foreign material has been eliminated. This Contractor shall submit chemical cleaning treatment and method to the Architect for approval.

D. Compressed air lines shall be blown out using compressed air. All filters and instruments shall be removed from system during this flushing and then replaced.

E. Chemical treatment required for cleaning shall be provided a specified under “Chemical Treatment”.

3.12 PIPING SYSTEM PRESSURE TESTS

A. All piping systems furnished and installed under this section shall be pressure and/or vacuum tested prior to being buried, concealed, and/or insulated. This Contractor shall make all necessary temporary connections and gauges required and shall isolate all equipment which may be damaged by testing procedures. This Contractor shall notify Architect in writing of his testing schedule to permit observation of

procedures. Tests shall be initiated only after testing medium has reached ambient temperatures. Systems which fail testing shall be repaired in a manner approved by the Architect and testing repeated. Testing of sections of extensive systems are permitted. Written summary of all testing shall be submitted upon completion of testing indicating system, date of test, testing medium, initial and final pressures and temperatures, repair procedures and supervisor's name.

B. The following systems shall be tested as indicated:

SYSTEM	TEST MEDIUM	TEST PRESSURE PSIG	TIME PERIOD HOURS	ALLOWED DEVIATION PERCENT	NOTES
Hot Water S&R (All)	Water	100	4	0	1
Chilled Water S&R	Water	100	4	0	1
Make-Up Water	Water	90	4	0	1
Chemical Feed	Air	350	4	-5	1
Refrigerant	Nitrogen	250	4	-5	3
Refrigerant	Vacuum	29.5" Hg	4	-5	3

Note 1: Water shall be clean, clear liquid.
Note 2: Compressed air shall be oil-free.
Note 3: Dry nitrogen shall be used for pressure test followed by vacuum test. Introduce refrigerant into piping to break vacuum.
Note 4: Water shall be plant demineralized water.

C. For testing of piping systems exposed to low ambient conditions, this Contractor shall assume responsibility of taking suitable precautions to prevent freezing within piping systems.

3.13 INSULATION APPLICATION REQUIREMENTS

A. Insulation materials shall be installed in accordance with the applicable insulation classes for piping, ductwork and equipment.

B. Insulation shall be applied in a workmanlike manner so as to provide a neat and smooth surface, suitable for painting. Work and/or material that is poorly done or done in a manner not conforming to the specifications and/or drawings shall be repaired or replaced as directed by the Architect.

C. Insulation shall not be applied to piping and related equipment until the completion of pressure testing. Insulation shall not be applied to ductwork and related equipment until air systems have been sealed and/or pressure tested.

D. Sections of piping and equipment may be covered as the work progresses, provided the above requirements have been met for pressure testing and tightness.

E. All piping and equipment to be covered shall be clean and dry prior to the application of insulation.

F. Insulation shall not be applied when ambient temperatures within the space are below 40 degrees F.

G. Piping and duct insulation shall be carried full thickness through all floor and wall openings, except when installed through sleeves through fire-rated construction, insulation shall be discontinued at the penetration and replaced with caulking material specified for sleeves.

H. All insulation shall be applied with edges tightly butted.

I. All voids and/or seams in insulation shall be filled with insulating cement plaster or insulating cement.

J. All insulation ends shall be finished to a 45 degree level with insulation cement troweled to a neat and smooth finish.

K. Equipment nameplates, pressure vessel code labels and equipment access doors shall be left exposed with insulation edges finished as described in Paragraph J. above.

L. Piping installed outdoors with the exception of underground conduit and condenser water piping shall be furnished with layers of insulation of equal thicknesses with the total thickness twice that specified in insulation thickness schedule. The double layer insulation shall be installed so that all seams are staggered. Apply 45 pound roofing felt with 2 inch overlap at joints. All joints to be sealed with asphalt. Wire jacket in place with 16 gauge copper annealed wire on 9 inch centers.

M. Under no circumstances shall pneumatic control tubing be covered with insulation.

N. When installation thickness specified exceeds that provided as manufacturer's standard, then multiple layered material shall be used to achieve specified thickness.

O. Any piping, ductwork or equipment which may convey a fluid gas or air below 75 degrees F. at any time in its normal operation shall be provided with insulation with an external vapor barrier except where explicitly indicated otherwise.

P. Where specified under Pipe Hangers, Supports and Hangers, insulated chilled water, cold make-up water or refrigerant suction lines shall have calcium silicate used at all points of support. Calcium silicate sections shall be of the same thickness as the adjacent insulation with vapor barriers continued unbroken through the support section. Support sections shall be three times the pipe diameter in length or not less than 12 inches nor more than 24 inches. 14 gauge galvanized sheet metal saddles the same length and diameter as the calcium silicate section and covering not less than 120 degrees of arc shall be provided at support points.

Q. Insulated hot water lines shall be provided with welded pipe saddles at all support points. Saddles shall fit the insulation outside diameter with insulation filling the void between pipe and saddle.

R. All chilled water, cold make-up water or other piping insulation with vapor barriers shall not be stapled. Sections of insulation which are stapled shall be removed and replaced with new material as specified.

S. Insulation for piping and equipment shall be provided with wire or band supports to prevent sagging and cracking of finished surface or vapor barrier. Supports shall be applied in accordance with insulation manufacturer's recommendations. Supports shall generally be located beneath finish jacketing.

T. Valves which are specified to be insulated shall be covered to top of bonnets.

U. Insulation for piping systems shall be provided up to coil connections and the exterior casing, including tube returns or manifolds external to casing shall also be insulated except where noted otherwise.

V. Engine exhaust pipes, fittings, and silencers shall be covered with 4 inch calcium silicate insulation. Insulation shall be applied in two (2) layers with staggered joints. Secure insulation in place with heavy gauge stainless steel bands. Seal all seams and joints in each layer with high temperature cement. Cover insulation with reinforced glass fiber cloth.

W. All unlined supply and return ductwork located outdoors shall have a minimum thickness of 2 inches of rigid board insulation and an aluminum weatherproof cover applied over the vapor barrier.

3.14 SYSTEM BALANCING

A. This Contractor, as part of his contract, shall obtain the services of a testing and balancing agency that specializes in this type of work, to perform the work required under this section.
   1. The testing and balancing agency selected shall not have installed, fabricated or engineered any part of the system that the testing and balancing work shall be performed on, so as to prevent any conflict of interest. This shall include but not be limited to drilling and patching holes, taking apart and re-assembling equipment, removing and replacing fan guards, removing and replacing control box covers, and changing belts and sheaves.
   2. In addition, the selected company shall not be a subsidiary of or be associated with persons having financial interests in the accessories, ductwork, and controls undergoing these tests so that the Owner will receive a completely unbiased test and balance report upon completion of the work.
   3. Additionally, the testing and balancing agency shall complete no work on the HVAC systems, where such work involves the installation or modification to the HVAC systems. Such work is solely assigned to the HVAC sub-contractor and their employees. Note that it is the intention of the paragraphs herein to assign full responsibility for labor, tools, corrections, installation of balancing dampers, installation or test openings, pullet changes, belt changes, and all other "work", which involves modifications or corrections to the HVAC system to HVAC sub-contractor. Where the testing and balancing agent is assigned "work" herein, such work shall be limited to testing, reporting, and providing sufficient information to the HVAC sub-contractor such that they can make necessary modifications or corrections for proper system operation.

B. The selected testing and balancing agency shall be a certified member of the AABC or the NEBB. Minimum criteria for this project shall be the General Membership

Standards of the Associated Air Balance Council, as published nationally in AABC NSFMI Volume One, #81266 or as otherwise noted herein.

C. All work performed by the approved agency shall be done in full accordance with minimum standards as set forth in AABC National Standards, Fourth Edition (1982) and ASHRAE Systems Manual (1984). In addition, vibration readings shall be taken on all rotating equipment in this section and recorded in mills of deflection.

D. Submittals:
1. The TAB Agency shall submit a company resume listing personnel and project experience in air and hydronic system balancing and a copy of the agency's Test and Balance Engineer (TBE) certificate.
2. The TAB agency shall submit the TAB procedures and agenda proposed to be used.
3. The TAB agency shall submit sample forms, which shall include the minimum data required by the AABC National Standards.

E. This Contractor shall cooperate with the test and balance agency in the following manner:
1. Provide sufficient time before final acceptance data so that tests and balancing can be accomplished and reviewed.
2. Provide immediate labor and tools to make corrections when required without undue delay. Install balancing dampers as required by test and balance agency.
3. Put all heating, ventilating and air conditioning systems and equipment into full operation and shall continue the operation of same during each working day of testing and balancing.
4. The testing and balancing agency shall be kept informed of any major changes made to the system during construction, and shall be provided with four (4) complete sets of Construction and Coordination drawings, one (1) set of which shall be turned over to the Owner with ductwork systems differentiated by coloring each system's ductwork in a distinguishing color and diffusers, registers and grilles identified with a number corresponding with the respective item on the balancing report.
5. Include the costs of test openings, dampers, pulley and belt changes in his contract.

F. The test and balance agency shall test and balance all air handling systems and equipment and shall also test and balance all hot water and make-up water systems. All systems shall be adjusted so that they achieve within 10 percent of design quantities, except over-all pressure relationship shall be maintained.
1. Where provided, air flow measuring devices shall be utilized to balance air system. Accuracy also shall be verified by the balancing agency.
2. Final adjustments to each variable volume and constant volume box shall be provided by the balancing agency.
3. Where combination balancing valve and flow measuring devices, or flow devices, are indicated, the balancing agency shall utilize them for balancing the water system.

G. The items requiring testing, adjusting and balancing include the following:
1. Air Systems:
   a. Supply Fans (including those in ERU's, RTU's, AHU's and FCU's)
   b. Return Fans (including those in RTU's)
   c. Exhaust Fans (including those in ERU's)

d. Zone Branch and Main Ducts
e. VAV Systems
f. Diffusers, Registers and Grilles
g. Coils (Air Temperature)

2. Hydronic Systems:
   a. Pumps
   b. System Mains and Branches
   c. Boilers
   d. Coils
   e. Chiller
   f. Radiant panels
   g. Fintube radiation.

H. TAB Preparation and Coordination:
1. Shop drawings, submittal data, up-to-date revisions, change orders, and other data required for planning, preparation, and execution of the TAB work shall be provided to the TAB agency no later than 30 days prior to start of TAB work.
2. System installation and equipment start-up shall be complete prior to the TAB agency's being notified to begin.
3. The building control system shall be complete and operational. The Building Control System Contractor shall install all necessary computers and computer programs, and make these operational. Assistance shall be provided for reprogramming, coordination, and problem resolution.
4. All test points, balancing devices, and identification tags shall be accessible and clear of insulation and other obstructions that would impede TAB procedures.
5. Qualified installation or start-up personnel shall be readily available for the operation and adjustment of the systems. Assistance shall be provided for coordination and problem resolution.

I. Reports:
1. The TAB agency shall submit the final TAB report for review by the Engineer. All outlets, devices, and HVAC equipment shall be identified, along with a numbering system corresponding to report unit identification. The TAB agency shall submit an AABC "National Project Performance Guaranty" assuring that the project systems were tested, adjusted and balanced in accordance with the project specifications and AABC National Standards.
2. Submit four (4) copies of the final TAB Report.

J. Deficiencies:
1. Any deficiencies in the installation or performance of a system or component observed by the TAB agency shall be brought to the attention of the appropriate responsible person.
2. The work necessary to correct items on the deficiency listing shall be performed and verified by the affected contractor before the TAB agency returns to retest. Unresolved deficiencies shall be noted in the final report.
3. System balance reports which, upon field inspection of the systems, are found to be erroneous, shall have the questioned systems corrected by the test and balance agency until a proper balance is achieved. Such correction work shall be done at no cost to the Owner. Balancing Contractor shall field verify balancing settings and measurements as randomly selected by the Architect.

K. All instruments used for measurements shall be accurate and calibrated. Calibration and maintenance of all instruments shall be in accordance with the requirements of AABC National Standards.

L. The specified systems shall be reviewed and inspected for conformance to design documents. Testing, adjusting and balancing on each identified system shall be performed. The accuracy of measurements shall be in accordance with AABC National Standards. Adjustment tolerances shall be + or – 10% unless otherwise stated.
   1. Equipment settings, including manual damper quadrant positions, manual valve indicators, fan speed control levers, and similar controls and devices shall be marked to show final settings.
   2. All information necessary to complete a proper TAB project and report shall be per AABC Standards unless otherwise noted. The descriptions for work required, as listed in this section, are a guide to the minimum information needed.

M. Air Systems:
   1. The TAB agency shall verify that all ductwork, dampers, grilles, registers and diffusers have been installed per design and set in the full open position. The TAB agency shall perform the following TAB procedures in accordance with the AABC National Standards.
   2. For Supply Fans:
      a. Test and adjust fan RPM to achieve maximum or design CFM.
      b. Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not in or above the service factor.
      c. Perform a Pitot-tube traverse of main supply and return ducts, as applicable to obtain total CFM.
      d. Test and adjust the outside air on applicable equipment using a pitot-tube traverse. If a traverse is not practical use the mixed air temperature method if the inside and outside temperature difference is at least 20 degrees F. or use the difference between pitot-tube traverses of the supply and return air ducts.
      e. Test and record system static profile of each supply fan.
   3. For Return Fans:
      a. Test and adjust fan RPM to achieve maximum or design CFM.
      b. Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not in or above the service factor.
      c. Perform a pitot-tube traverse of the main return ducts to obtain total CFM.
      d. Test and record system static profile of each return fan.
   4. For Exhaust Fans:
      a. Test and adjust fan RPM to achieve maximum or design CFM.
      b. Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure motor is not in or above the service factor.
      c. Perform a pitot-tube traverse of main exhaust ducts to obtain total CFM.
      d. Test and record system static profile of each exhaust fan.
   5. The Balancing Contractor shall make all necessary tests and measurements and provide information to provide for replacement of adjustable sheaves

utilized for initial balancing with optimum sized fixed sheave and select optimum replacement sheave sizes for existing equipment fan drives for systems indicated to be modified. All adjustable sheaves replaced shall be tagged to indicate which unit it was on and turned over to the Owner.

6. For Zone, Branch and Main Ducts:
   a. Adjust ducts to within design CFM requirements. As applicable, at least one zone balancing damper shall be completely open. Multi-diffuser branch ducts shall have at least one outlet or inlet volume damper completely open.
7. For VAV Systems:
   a. Set volume regulators on all terminal boxes to meet design maximum and minimum CFM requirements.
   b. Identify the type, location, and size of each terminal box. This information shall be recorded on terminal box data sheets.
8. For Diffusers, Registers and Grilles:
   a. Test, adjust and balance each diffuser, grille and register to within 10% of design requirements. Minimize drafts.
   b. Identify the type, location, and size of each grille, diffuser and register. This information shall be recorded on air outlet data sheets.
9. For Coils:
   a. Once air flows are set to acceptable limits, take wet bulb and dry bulb air temperatures on the entering and leaving side of each cooling coil. Dry bulb temperature shall be taken on the entering and leaving side of each coil.
10. Where air balancing cannot be completed due to lack of air flow and the reason for the lack of air flow cannot be identified, a static profile shall be performed to identify the reason for loss of adequate air flow.

N. Hydronic Systems:
1. The TAB agency shall, as applicable, confirm that all hydronic equipment, piping, and coils have been filled and purged; that strainers have been cleaned; and that all balancing valves (except bypass valves) are set full open. The TAB agency shall perform the following testing and balancing functions in accordance with the AABC National Standards.
2. For Pumps:
   a. Test and adjust hot water pumps to achieve maximum or design GPM. Check pumps for proper operation. Pumps shall be free of vibration and cavitation. Record appropriate gauge readings for final TDH and Block-Off/Dead Head calculations.
   b. Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure pump motor is not in or above the service factor.
3. For System Mains and Branches:
   a. Adjust water flow in pipes to achieve maximum or design GPM.
4. For Boilers:
   a. Verify that boilers have been filled and started, and are in operation.
   b. As applicable, test and record motor voltage and amperage, and compare data with the nameplate and limits to ensure motor is not in or above the service factor.
   c. Test and adjust water flow through water boilers.
   d. Test and record temperature and pressure profiles of water boilers.

5. For Coils:
   a. Test, adjust and balance all chilled water and hot water coils within 10% of design requirements.
   b. Verify the type, location, final pressure drop and GPM of each coil. This information shall be recorded on coil data sheets.

O. The TAB agency shall conduct sound testing in the following areas per AABC National Standards and to the criteria listed, using sound meter with octave band analyzer:

1.

Test Area	Number of Locations	NC Level Acceptable
General Office	16	30-35
Computer/Equipment Rooms	4	40-45
Schools/Classrooms	16	25-30

P. The TAB agency shall conduct vibration testing on the following equipment per AABC National Standards. Test deflection in mils and velocity in inches per second shall be measured and the results compared to requirements in equipment specification sections.

1. EQUIPMENT
   Fans over 3.0 Horsepower
   Pumps over 3.0 Horsepower

Q. Indoor Air Quality Verification:
1. The TAB agency shall take measurements at design outside air. It shall measure temperature and humidity uniformity throughout the space, check filter installation for proper fit, seal, and operation and verify condensate drain operation. The TAB agency shall note any water damage or obvious contamination sources from inside or outside.
2. The TAB agency shall conduct the following air sampling tests for every 2,500 square feet of space:
   a. Carbon Dioxide
   b. Carbon Monoxide
   c. Ozone
   d. Nitrogen Oxides
   e. Formaldehyde
3. The TAB agency shall prepare a report showing the results, location, time and date of each test. A summary of the HVAC operating conditions, and a listing of any discrepancies shall be provided.
4. All IAQ readings are applicable only to the date and time noted on report.

R. The TAB agency shall review the project documents and Contractor submittals for their effect on the TAB process and overall performance of the HVAC system. It shall submit recommendations for enhancements or changes to the system within 30 days of document review.

S. During construction, the TAB agency shall inspect the installation of pipe systems, sheet metal work, temperature controls, and other component parts of the HVAC systems. Inspections shall be conducted a minimum of two times. (Typically, these are performed when 60% of the total system is installed and again when 90% of the total system is installed, prior to insulation of the duct and piping.) The TAB agency shall submit a written report of each inspection.

T. The Installing Contractor shall isolate and seal sections of ductwork for testing. The test pressures required and the amount of duct to be tested shall be described by the Engineer in the appropriate duct classification section. All testing shall be based on one test per section only unless otherwise noted.

U. The TAB agency shall be assisted by the Building Control Systems Contractor in verifying the operation and calibration of all HVAC and temperature control systems.
1. Automatic Temperature Control Contractor shall have all automatic valves adjusted and calibrated prior to balancing.
2. The Balancing Contractor shall make all necessary tests and measurements and provide information as required by the Automatic Temperature Control Contractor to select the optimum range of sensing and control devices.
3. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water resets, fire and freezestats, and other safety devices.
4. Verify that all controlling instruments are calibrated and set for design operating conditions.

V. To verify system control and operation, a series of three temperature tests shall be taken at approximately two hour intervals in each separately controlled zone. The resulting temperatures shall not vary more than two degrees F. from the thermostat or control setpoint during the tests. Outside temperature and humidity shall also be recorded during the testing periods.

W. At the time of final inspection, the TAB agency may be required to recheck, in the presence of the Owner's representative, specific or random selections of data recorded in the certified report. Points and areas for recheck shall be selected by the Owner's representative. Measurements and test procedures shall be the same as approved for the initial work for the certified report. Selections for recheck, specific plus random, will not exceed 10% of the total number tabulated in the report.

X. The TAB agency shall test and adjust fume hood total air flow by duct pitot-tube traverse. If a pitot-tube traverse is not practical, an explanation of why a traverse was not made must appear on the appropriate data sheet. Test and record face velocities under design operating conditions using a maximum of a one square foot grid pattern across the entire open face. The TAB agency shall set sash height on hoods to obtain face velocities within 20% of 100 feet per minute unless specified otherwise. It shall test and adjust VAV controllers to obtain design exhaust air flows and make-up air flows to maintain design hood pressures and face velocities, and design room pressurization. The TAB agency shall test for turbulence and proper air flow patterns at the face and inside the hoods using a hand-held smoke puffer or other approved smoke-emitting device.

Y. The TAB agency shall test and adjust building/zone pressurization by setting the design flows to meet the required flow direction and pressure differential. For positive pressure areas, it shall set the supply air to design flow, and gradually reduce the exhaust air rate to obtain the required flow or pressure difference. For negative pressure areas, it shall set the supply air to design flow, and gradually increase the exhaust air rate to obtain the required flow or pressure difference.

Z. The TAB agency shall test and record life safety control operation on the HVAC equipment. It shall verify the installation of required smoke detectors in air handling equipment (AHE), and shall verify operation of the smoke detector by activating the smoke detector and observing air handler shut-down. With the controls and alarm contractors, the TAB agency shall verify the operation of interconnected systems such as the AHE smoke detector's activation of the fire alarm system and the alarm system's activation of the life safety control sequences.

END OF SECTION

SECTION 26 00 00
ELECTRICAL

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END OF SECTION 125

SECTION 26 00 00

ELECTRICAL

PART 1 GENERAL

1.1 GENERAL PROVISIONS

A. Sub-Bid Requirements: As provided under Section 26 00 01 – Electrical Filed Sub-Bid Requirements and supplemented under the Bidding Requirements, Contract Forms, and Conditions of the Contract, and applicable parts of Division 1 – General Requirements.

1. Work of this Filed Sub-Bid includes all individual Specification Sections listed in Section 26 00 01.

1.2 GENERAL REFERENCES

A. Bidding Requirements, Contract Forms, General Conditions Contract for Construction Services and Division 1, General Requirements are hereby made a part of this Section.

1.3 SCOPE OF WORK

A. The scope of work consists of the installation of all materials to be furnished under this Section, and without limiting the generality thereof, consists of furnishing all labor, materials, equipment, plant, transportation, rigging, staging, appurtenances and services necessary and/or incidental to properly complete all electrical work as shown on the Drawings, as described in the Specifications, or as reasonably inferred from either, in the opinion of the Architect as being required.

B. The work of this Section includes:
1. Primary electric service.
2. Secondary electric service and metering.
3. Switchboard.
4. Grounding.
5. Sleeves, inserts and openings.
6. Pullboxes, junction boxes and wireways.
7. Panelboards.
8. Dry-type transformers.
9. K-rated transformers.
10. Conduit.
11. Wire and cable.
12. Electrical supporting devices.
13. Outlet boxes and accessories.
14. Wiring devices and plates.
15. Floor outlets.
16. Lighting fixtures and lamps.
17. Starters.
18. Disconnect switches.
19. Emergency standby systems.
20. Fire alarm system.

21. Public Safety Signal Booster System.
22. Lightning Protection System.
23. Building preparation for Communications System, Specifications Sections 27 10 00, 27 21 33, 27 40 00, 27 50 00 and 27 70 00.
24. Building preparation for Electronic Safety and Security Systems, Specifications Sections 28 13 00, 28 16 00 and 28 23 00.
25. Surge Protective Devices (SPD'S)
26. Cable Tray and accessories.
27. Lighting control system.
28. Nameplates.
29. Fuses.
30. Thermal switches.
31. Access panels.
32. Timeclocks.
33. Scoreboards.
34. Installation of theatrical lighting equipment as furnished by Section 11 61 11 and wiring and conduit to connect theatrical lighting equipment and Building preparation as indicated on Drawings.
35. Short Circuit/Coordination/Selective Coordination Study.
36. Small Group Seminar Dimming System.
37. Athletic (Sports) Site Lighting.
38. Mineral Insulated Metal – Sheathed System (MI Cable).
39. Destratification Fans.
40. Telephone/Data/Video Outlet and Conduit System.
41. Off Grid Solar Panel System.

C. The Electrical Subcontractor shall be responsible for all cutting related to the work of this Section except in finished surfaces. Patching is the responsibility of the trade effected.
   1. For coordination of cutting and patching refer to Section 01 31 00, Project Management and Coordination.
   2. For cutting and patching Specifications, refer to Section 01 73 00, Execution.

1.4 RELATED WORK SPECIFIED ELSEWHERE

A. The following related work or material shall be provided under the designated Divisions:
   1. Excavation, backfill, pumping, and shoring: Division 31, "Earthwork."
   2. Concrete work: Division 03, "Concrete."
   3. Flashing and counterflashing for all roof openings: Division 07, "Thermal and Moisture Protection."
   4. Field Painting: Division 09, "Finishes."
   5. Specialty Equipment: Division 11, "Equipment."
   6. Elevator: Division 14, "Conveying Systems."
   7. Sprinkler System: Section 21 00 00, "Fire Suppression."
   8. Plumbing Equipment: Section 22 00 00, "Plumbing."
   9. HVAC Equipment: Section 23 00 00, "HVAC."
   10. Door Hardware: Section 08 71 10.
   11. For restrictions concerning the hanging of materials, piping, mounts, brackets, hangers, hooks and other items from metal decking. Steel Decking, Section 05 31 00.

12. Communications System, Sections 27 10 00, 27 21 33, 27 40 00, 27 50 00 and 27 70 00.
13. Electronic Safety and Security Systems, Sections 28 13 00, 28 16 00 and 28 23 00.

1.5 DEFINITIONS

A. "E.C." or "Contractor" as used herein after in this Section shall mean the "Electrical Subcontractor," i.e., the filed bid Subcontractor under this Section 26 00 00.

B. "Concealed" shall be defined as areas where conduit and wiring is located in chases, walls, partitions, shafts, and above finished ceilings.

C. "Underground" shall mean conduit and wiring exterior to or within the Building that is buried. All other conduit and wiring shall be considered "exposed."

D. "Exposed" shall mean conduit and wiring run on the surface of the Building construction.

E. "Conduit" shall mean in addition to conduit, all fittings, hangers and other accessories relating to such conduit systems.

F. "Provide" shall mean "provided complete in place," that is, "furnished and installed."

1.6 EXAMINATION OF SITE AND CONTRACT DOCUMENTS

A. Bidders are advised to visit the site and inform themselves as to conditions under which this work will be performed. Failure to do so will, in no way, relieve the successful bidder from the responsibility of furnishing any materials or performing any work in accordance with the true intent and meaning of the Drawings and Specifications.

B. No claim for extra compensation will be recognized if difficulties are encountered which an examination of the site conditions and contract documents prior to executing the contract would have revealed.

C. This Contractor shall be responsible for ordering and furnishing the correct quantity of material required. Routing and equipment arrangements shown on the Drawings are approximate only and are not warranted to be accurate.

D. Arrangements shall be made with the Owner prior to the visit for inspection of the existing Buildings.

1.7 RECORD DRAWINGS

A. General: Refer to Division 1, General Requirements, Section 01 78 00, Closeout Submittals for Requirements.

B. The record Drawings required to be furnished under this Section are of the "E", "T", "TL", and "TR" Series Drawings.

1.8 SHOP DRAWINGS

A. General: Refer to Division 1, General Requirements, Section 01 33 00, Submittal Procedures, for submittal provisions and procedures.

B. In accordance with Division 1, General Requirements, submit to the Architect for approval complete sets of detailed information consisting of manufacturer's' bulletins, capacities, Shop Drawings, and parts lists of all material to be provided for this project.

C. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is NOT a proprietary Specification and it should be noted that or approved equal applies to all products denoted herein. It is understood that all manufactures will have minor variations in configuration, appearance, and product Specifications and such minor variations shall not eliminate such manufacturer's as an approved equal. It is the intent of this Specification to encourage open and competitive involvement from multiple manufacturer's that are able to supply similar products.

1.9 MOCK-UPS

A. General: Refer to Division 1, General Requirements, Section 01 43 29, Mock-Ups for requirements.

B. The Electrical Subcontractor will be required to mock-up (1) typical classroom and (1) typical science classroom as described in Section 01 43 29.

1.10 CODES, REGULATIONS AND PERMITS

A. All work done under this Section shall conform to the Codes and regulations governing such work as follows:
1. ANSI American National Standards Institution
2. ASTM American Society for Testing Materials
3. CS Commercial Standards
4. FS Federal Specifications
5. IEEE Institute of Electrical and Electronic Engineers
6. IES Illuminating Engineering Society
7. NEC National Electrical Code
8. Massachusetts Electrical Code
9. NECA National Electrical Subcontractors Association
10. NEMA National Electrical Manufacturer's Association
11. NFPA National Fire Protection Association
12. UL Underwriters Laboratory
13. NESC National Electrical Safety Code
14. IPCEA Insulated Power Cable Engineers Association
15. EEI Edison Electrical Institute
16. EIA Electronic Industry Association
17. All Local Governing Codes.

B. Give notices, file plans, obtain and pay for permits and licenses and obtain necessary approvals from authorities having jurisdiction. Permits shall be secured through the City. Deliver certificates of inspection to Architect. No work

shall be covered before examination and approval by Architect, inspectors and authorities having jurisdiction. Imperfect or condemned work shall be replaced with work conforming to requirements, without extra cost to Owner, subject to the approval of the Architect. If work is covered before due inspection and approval, the Electrical Subcontractor shall pay costs of uncovering the installed work, whether it meets contract requirements or not. Refer to Section 00 21 13 Instruction to Bidders and General Conditions Contract for Construction Services for payment of fees.

1.11 INTENT

A. It is not intended that the Drawings show every conduit, fitting and appurtenance. All such parts necessary for the complete execution of the work, in accordance with the best practices of the trade and to the satisfaction of the Architect shall be provided whether these parts may have been specifically mentioned or not, or indicated on the Drawings.

1.12 DRAWINGS AND SPECIFICATIONS

A. The Drawings and Specifications are complementary each to the other, and any labor or material called for by either, whether or not by both, or necessary for the successful operation of any components shall be furnished and installed.

B. Before installing any work, verify that it does not interfere with the clearances required for other work. Installed work which interferes with existing necessary services shall be modified as directed by the Architect, at no additional cost to the Owner.

C. Be familiar with the Drawings and Specifications of all other trades to prevent interferences and assure complete coordination.

1.13 GIVING INFORMATION

A. Keep fully informed as to the shape, size and position of all openings and foundations required for all apparatus furnished under this Section and give full information to the General Contractor sufficiently in advance of the work, so that all such openings and foundations may be built in advance. Furnish all sleeves and supports herein specified, so the General Contractor may install same in place.

B. In the case of failure to give proper information as noted above, assume the cost of having necessary changes to the work made by the General Contractor.

1.14 OBTAINING INFORMATION

A. Obtain detailed information from the manufacturer's of apparatus which is to be provided, for the proper methods of installation. Obtain all information from the General Contractor and other Subcontractors which may be necessary to facilitate the work and the completion of the whole project.

C. Electrical Subcontractor shall inspect the site associated with this project prior to submitting his bid and shall investigate all conditions under which this work will be performed. This shall include determination of exact

locations of items indicated as existing on the Drawings. Such existing locations are diagrammatic and shall not be construed as exact enough to use for equipment and labor estimating purposes. Failure to inspect existing conditions or to fully understand the work which is required shall not excuse the Electrical Subcontractor from his obligation to supply and install work in accordance with the Specifications and Drawings and under all existing site conditions. It shall be the responsibility of the Electrical Subcontractor to investigate and locate all existing underground utilities which may conflict with the installation of this electrical work. Coordinate elevations of conduits required to be installed under this Contract to avoid interference with any existing underground utilities.

1.15 MATERIALS AND EQUIPMENT

A. All materials and equipment furnished under this Section shall be new and of the best grade for the service intended. The manufacturer's mentioned in the Specifications are intended to indicate the quality desired. Any substitutions shall be approved by the Architect as herein provided by the "or equal" clause, in addition to meeting the limitations of space and capacity shown or specified. Re-built materials and equipment will not be accepted.

1.16 ELECTRICAL CHARACTERISTICS

A. In general, and unless specifically indicated otherwise in the Specifications or noted on the Drawings, all new Building service, heating, ventilating, air conditioning and plumbing equipment shall be of the following characteristics:
   1. Motors up to and including 1/3 HP shall be suitable for 120 volt, single phase operation.
   2. Motors larger than 1/3 HP shall be suitable for 480 volt, three phase operation.

1.17 TEMPORARY LIGHT AND POWER

A. Provide capacity from the local utility company power lines, make arrangements with the local utility company for temporary service and pay all expenses related thereto.

B. Refer to Division 1, Section 01 50 00 for requirements.

1.18 OPERATIONS AND MAINTENANCE MANUALS

A. At least two (2) months prior to the time of turning over this contract to the Owner for use and occupancy or substantial completion, secure and deliver to the Architect three (3) complete indexed files containing approved operating and maintenance manuals, shop Drawings and other data as follows:
   1. Operation description of all systems.
   2. Complete shop Drawings of all equipment.
   3. Preventive maintenance instructions for all systems.
   4. Spare parts lists of all system components.
   5. Names, addresses and telephone numbers of all suppliers of the systems.

B. Non-availability of operating and maintenance manuals or inaccuracies therein may be grounds for cancellation and postponement of any scheduled final inspection by the Owner until such time as the discrepancy has been corrected and/or retainage of sufficient monies to prepare same.

C. Provide qualified trained personnel to insure proper operation of the systems and to train the Owner's operating and maintenance personnel in the proper operation and maintenance of the systems. Instruction period shall be five (5) eight-hour days.

1. Training of the Tenant's and Building Owner's operation and maintenance personnel is required in cooperation with the Tenant's and Building Owner's Representatives. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Tenant's and Building Owner's Representative after submission and approval of formal training plans. Refer to Commissioning Specification, Section 01 91 00, for contractor training requirements.

1.19 GUARANTEE AND SERVICE

A. The Electrical Subcontractor shall guarantee the performance of the installation and all equipment included in this Section in writing for a minimum of two years from the date of final acceptance of same. Where indicated in these Specifications that more than two years of guarantee is required, provide guarantee as indicated in that particular Specification Section. Should any defects in materials or workmanship appear during the period, they shall be corrected or replaced by the Electrical Subcontractor to the satisfaction of the Architect, and at no additional expense to the Owner.

1.20 DEBRIS REMOVAL AND CLEAN-UP

A. The Electrical Subcontractor shall, at the end of each days work, remove waste materials and debris resulting from the installation of the electrical system. The Electrical Subcontractor shall deposit such waste and debris in a dumpster on-site. Dumpster shall be provided by the General Contractor. The General Contractor shall be responsible for the emptying of dumpster when required.

B. The Electrical Subcontractor shall, at the completion of his work, remove from the property all tools, equipment and surplus materials resulting from the installation of the electrical system.

1.21 COMMISSIONING REQUIREMENTS

A. An independent Commissioning Agent (CA) will be retained for this project. The commissioning process will be implemented in accordance with the LEED for Schools v2009 and Commissioning Credits EAp1 – Fundamental Commissioning of Building Energy Systems and EAc3 – Enhanced Commissioning.

B. This contractor shall assist and support the CA as necessary in accordance with the requirements of Specification Section 01 91 13 – Commissioning Requirements/Plan.

1. Commissioning of a system or systems specified in this Section is part of

the construction process. Documentation and testing of these systems, as well as training of the Tenant's and Building Owner's operation and maintenance personnel, is required in cooperation with Tenant's and Building Owner's Representatives and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation and issue closure. Refer to Commissioning Requirements/Plan, Section 01 91 13, for detailed commissioning requirements.

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Nameplates shall be furnished and installed on the meter centers/switchboard and meter centers/switchboard circuit breakers, panelboards, dry-type transformers, junction boxes, cabinets for all special purpose switches, motor disconnect switches, starters and other controls furnished under this Contract, to designate the equipment controlled and function.

B. Nameplates shall be laminated white bakelite with 1/4" high black recessed letters. Nameplates shall be securely attached to the equipment with galvanized screws or rivets. Adhesives or cements will not be permitted.

C. All pull boxes and junction boxes shall be identified as to system and function by means of black fibre pen.

2.2 ELECTRICAL SWITCHBOARD

A. Furnish and install a NEMA One, Class One Switchboard. The equipment and major components shall be suitable for and certified by actual seismic testing to meet all applicable seismic requirements of the International Building Code (IBC) Site Classification as based on installed location zip code. The manufacturer shall provide the tested baseline mounting location information to the Contractor. The installing Contractor shall complete all required installation calculations and mount the unit based on the engineered to site plans.

B. Switchboard shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides and rear shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.

C. All sections of the switchboard shall be a minimum of 90 inches high and group distribution sections shall be no more than 30 inches deep. All vertical sections shall rear align.

D. All switchboard components shall be either front or side accessible. Where space for future is called for, all necessary bus extensions except devices connecting straps shall be provided.

E. The switchboard assembly and all circuit breakers shall be rated for short-circuited stresses as indicated on Drawings.

F. Fully Rated equipment shall be provided; Series Rated equipment is not acceptable.

G. All main bus bars shall be silver-plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on NEMA standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure). No portion of the horizontal bus shall extend within 8 inches of the bottom or within 8 inches of the front inside any vertical panel section of the switchboard structure.

H. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and finished with gray enamel over a rust-inhibiting phosphatized coating.

I. The switchboard shall have an UL service entrance equipment label.

J. The switchboard layout and rating shall be as indicated on the plans and shall have the following features:
1. Service entrance shall be by means of conduit entering from the bottom.
2. Provide a main molded case circuit breaker for ratings 1600 amperes and below. Provide main insulated case circuit breaker for all ratings 2000 amperes and above. Circuit breakers which are rated at 1200 amps or more shall have Arc Energy Reduction complying with National Electrical Code 240.87.
3. Provide Digitrip or equal electronic trip unit with integral GF protection on all main breakers. Provide thermal magnetic or ETU for feeders as shown on Drawings.
4. Provide National Electrical Code compliant arc reduction maintenance protection with separate maintenance settings, activation switch and light for all main breakers.
5. Main section shall be equipped with a line side digital power quality meter style IQ 260 or equivalent. Unit shall monitor voltage, amperes, power usage, and harmonic content displayed on the board and available for interface via modbus communications. Mount the unit in a separate compartment with system rated AIC disconnect device and shorting block for Line mounted CT's.
6. Each switchboard section shall have full ampere bussing with full neutral capacity. A ground bus bonded to each cubicle shall run throughout the switchboard and all buses shall be copper.
7. Internal busing and circuiting shall conform to the power riser diagram shown on the plans.
8. Distribution sections shall consist of circuit breakers group mounted with bolted connectors to bus all front accessible. See schedule on Drawings for frame size and trip unit types.
9. Where shown on Drawings provide electric utility company metering section that meets all local electric utility company requirements. Provide CT and PT units if required by the electric utility company. Provide all required documentation for electric utility company compliance review prior to construction of the switchboard.

K. The switchboard shall be a Pow-R-Line C as manufactured by Eaton, Square D, Siemens, or equal.

2.3 PANELBOARDS

A. At each location indicated on the plans, furnish and install an appropriate panel of the ampacity and voltage rating shown on the Drawings.

B. All panels shall be of the safety dead front circuit breaker type for service on three phase, four wire mains unless otherwise specified. All panels shall be of code Gauge Steel.

C. Panels shall be surface or flush mounted, as indicated on the plans, and installed so that the top circuit breaker is no more than 6'0" above the finished floor.

D. The panelboards shall bear the Underwriters' Laboratories Label.

E. All buses shall be copper. All panelboards shall have a circuit directory card mounted in a frame with plastic cover installed on the inside of the door. All directory cards shall be properly filled in, using a typewriter, and indicating areas and devices served by each circuit.

F. All circuit breakers shall be of quick-make and quick- break type on manual operation, trip-free, and with inverse time characteristics and shall have bolted bus connections; plug-in circuit breakers will not be allowed.

G. Panelboard trims shall have single doors. Trims and doors shall be made of code gauge, full finish sheet steel. The trim and doors shall be factory finished on both sides. All panelboards shall be keyed alike.

H. Panelboards shall contain circuit breakers indicated on panelboard schedule on the Drawings. Two and three pole breakers shall be common trip type.

I. All panelboards shall be equipped with a neutral bar having one solderless connector for each circuit as indicated and with all required knockouts.

J. Panelboards requiring 200% neutrals and isolated ground shall be as indicated on the Drawings.

K. Panelboards shall be Square D, Type NQOB for 120/208 volt, Type NEHB for 277/480 volt, and I-Line for main distribution panels, Eaton/Cutler-Hammer, Siemens, or equal.

L. Provide panel with Nema 4X enclosure in Kitchen, Servery, and other wash down areas.

M. Circuit breakers which are rated at 1200 amps or more shall have Arc Energy Reduction complying with National Electrical Code 240.87.

N. Fully Rated equipment shall be provided; Series Rated equipment is not acceptable.

2.4 PULL BOXES, JUNCTION BOXES AND WIREWAYS

A. Pull boxes shall be of code gauge galvanized steel with screw covers to match. Pull boxes and wireways shall be as shown on contract Drawings and/or comply with the National Electrical Code and/or job conditions, with steel barriers separating systems.

B. Wireways shall be of code gauge steel, baked enamel manufactured standard sections and fittings, with combination hinged and screw covers, as manufactured by Square D “Square-Duct,” Bee Line, Cope or equal.

C. Conductors passing through pull boxes and wireways shall be identified to indicate their origin and termination. Provide nameplates for all pull boxes.

D. Weatherproof junction boxes installed in grade shall be polymer concrete with gasketed cover, minimum 6” X 8” as manufactured by Quazite, Nordic Fiberglass, High Line Products, or approved equal.

2.5 OUTLET BOXES AND ACCESSORIES

A. Outlet boxes and accessories shall be as manufactured by Steel City, Appleton, Raco, or equal.

B. Lighting outlets in concrete ceilings, walls and columns shall be 4” octagonal rings, 4” deep with round bottom plate. Where concrete slab is less than 5” thick, boxes shall be 2-1/2” deep.

C. For wood framing and furred ceilings use 4” octagonal outlet boxes, bar hangers and covers. 4-11/16” boxes and covers shall be used where 1” conduit is involved.

D. Where outlets occur in beams or ribs of pan type concrete construction, a 4” shallow pan outlet, 3/4” deep, shall be used with conduit entering the back of the box.

E. All fixture outlet boxes shall have 3/8” solid make fixture studs and all auxiliary fixture stems shall be supported from 3/8” male fixture studs.

F. All outlets in walls other than lighting outlets in concrete shall be Series 52171, 4” square boxes with single of 2- gang raised covers, Series 52C50, of the proper depth required for the particular wall construction and finish. Where the wall construction or finish will not permit a neat cut around the raised cover, Series GW235 boxes shall be used.

G. Outlets in 2” partitions shall be 4” square, 1-1/4” deep, with raised cover.

H. Outlet boxes for weatherproof concealed work and exposed rigid conduit work shall be suitable cast or malleable iron conduit fittings, Crouse-Hinds Company, Appleton, Killark, or equal, and shall have threaded conduit hubs.

I. Floor outlets shall be as indicated on Drawings.

J. Fire rated poke thru’s shall be as indicated on Drawings.

2.6 CONDUIT

A. Electric metallic tubing shall be electrogalvanized or sherardized steel and the rigid steel conduit shall be hot-dipped galvanized or sherardized, inside and outside, manufactured by one of the following: Pittsburgh Standard, Republic Steel Corp., Allied Tube and Conduit Corp. or equal.

B. Flexible metal conduit shall be galvanized steel and shall contain a separate copper grounding conductor. Liquid-tight flexible metal conduit shall be similar, but shall also have an extruded moisture and oil proof outer jacket of polyvinyl chloride plastic.

C. Non-Metallic Conduit (NMC): Rigid polyvinyl chloride (PVC) shall be Schedule 40, rated for use with 90 degree conductors, UL rated or approved equal, conforming to industry standards and NEMA TC-2, NEMA TC-3, Fed. Spec. W-C-1094, and UL 651.

D. Rigid steel conduit fittings, couplings and connectors shall be threaded and shall be galvanized or cadmium plated. Conduit fittings and outlet boxes shall be held in place by fittings of a type approved by the Architect. Steel supports or racks shall be galvanized steel channel and fittings, Unistrut, Kindorf or Husky Products Company, or equal.

E. Couplings and connectors for electric metallic tubing shall be galvanized steel of the compression type other than the identer type and with insulated throat or set-screw type.

F. Steel support rods or support bolts for conduits shall be 1/8” diameter for each inch or fraction thereof of diameter of conduit size, but no rod or bolt shall be less than 1/4” in diameter.

G. Conduit shall be supported from the Building structure, and shall be independent of ducts, pipes, ceilings and their supporting members.

2.7 WIRE AND CABLE

A. Wiring shall be a minimum of #12 AWG solid, except motor control circuit wiring and fire alarm system wiring may be #14 AWG. Wiring for 120V branch circuits which exceed a distance of 100' from the panel to the last outlet shall be #10 AWG, 200 ft. from the panel to the last outlet shall be #8 AWG and 300 ft. from the panel to the last outlet shall be #6 AWG minimum, wiring for 277V branch circuits which exceed a distance of 200' from the panel to the last outlet or light fixture shall be #10 AWG, and 300 ft. from the panel to the last outlet or light fixture shall be #8 AWG minimum. The Electrical Subcontractor shall be required to perform voltage drop calculations on all branch circuits in which the actual proposed routing of the circuit exceeds 100 ft. to insure a maximum voltage drop of 3% is not exceeded. Wire sizes shall be increased to maintain the maximum 3% voltage drop.

B. Wires and cables shall be single conductor, except as otherwise specified or indicated on Drawings. Wires of sizes #8 AWG and larger shall be stranded. Wires of sizes smaller than #8 AWG shall be solid. Conductors shall be of soft drawn copper and shall have a conductivity of not less than 98% of the ANSI Standard for annealed copper. If, in the opinion of the Architect, the order and delivery time of solid conductors in the smaller sizes will delay progress of the installation, the Electrical Subcontractor may use stranded conductors instead of solid. If this permission is granted, pressure type connectors (not wire nuts) shall be used in making all such conductor splices, and particular care shall be taken when cutting insulation from ends of conductors not to score or sever conductor strands. Pressure type connectors shall also be used at all terminals.

C. Wire shall be Type THWN-2, XHHW or approved equal, rated 90 degrees C. minimum and suitable for wet and dry locations.

D. MC cable may be used for branch circuit wiring only, where run concealed, where allowed by Code and approved by the Authority Having Jurisdiction. Type MC cable shall be supported and secured at intervals not exceeding six feet.

E. Wire and cable shall be by one of the following: Phelps Dodge Copper Products Corp., General Cable Co., Triangle Conduit and Cable Co., or equal.

F. Terminal lugs and splice connectors shall be of an ampacity equal to the circuit on which they are utilized.

G. Emergency feeders that cannot be run in conduit below grade shall be Mineral Insulated Metal – Sheathed Cable (MI Cable), refer to Specification Section.

H. All wiring where run in environmental air plenums shall conform to Article 300-22 of the National Electrical Code.

I. Wiring shall be supported from the Building structure, and shall be independent of ducts, pipes, ceilings and their supporting members.

2.8 WIRING DEVICES

A. Light Switches

1. All local wall switches shall be of the flush quiet toggle type, single pole, double pole, three-way or four-way, and as manufactured by Pass and Seymour, Inc., Hubbell, Leviton Manufacturing Co., or equal.
2. All switches shall be suitable for the control of tungsten filament lamps, and shall carry the proper marking of the Underwriters' Laboratories.
3. Local switches shall be installed in such a position that they shall bear evenly and truly, and be secured on the axis of the supporting members.
4. Under no circumstances are wooden wedges, shims or blocks to be used in truing up local switches. Should the outlet box in any case come too far back of the finished surface, recess boxes and screws of the proper length to reach the box shall be used of such a size as to form a shoulder at exactly the proper point to retain the switch in position.
5. Switches shall be equal to the following:
   Single Pole Pass and Seymour 20 AC-1 (20 AMP-1P)
   Double Pole Pass and Seymour 20 AC-2 (20 AMP-1P)
   Three-Way Pass and Seymour 20 AC-3 (20 AMP-1P)
   Four-Way Pass and Seymour 20 AC-4 (20 AMP-1P)
   Switch with pilot light Pass and Seymour 20 AC-1-CPL (20 AMP-1P)
   Key switches shall be equal to corresponding switches above.
6. Dimmer switches shall be slide control dimmers with preset, Pass and Seymour 92080, Leviton Manufacturing Company, Lutron or equal, rated for 2000 watt, 120 volt AC operation.
7. Color of switches shall be white, unless otherwise noted.

B. Receptacles

1. Duplex receptacles shall be grounding type, rated 20 amperes, 125 volts. Receptacles shall be back and side wired with screw type terminals or pressure type, screwless terminals having suitable conductor release arrangement.

2. Ground fault duplex receptacles shall be furnished and installed where shown on the plans.
3. Special receptacles for single equipment, where required, shall have additional grounding leg and shall be of capacity for the equipment to be connected.
4. In general, convenience receptacle circuits shall be independent of lighting circuits and shall not be controlled by lighting circuit breaker switches or lighting switches, unless specifically indicated on the Drawings.
5. Receptacles shall be as follows, or as manufactured by Hubbell, Leviton Manufacturing Co., or equal:
   a. Normal circuit duplex receptacles - Pass and Seymour 5362 (Provide child proof tamper resistant receptacles in the Child Development Areas or Rooms).
   b. Duplex receptacles w/GFI - Pass and Seymour 2091S
   c. Receptacles with isolated ground - Pass and Seymour IG 5362 – Color of receptacles shall be orange.
   d. Computer circuit duplex receptacles – Pass and Seymour 5362-GRY – Color of receptacles shall be gray. All receptacles circuited to “C” panelboards shall be gray.
   e. Emergency circuit duplex receptacles – Pass and Seymour 5362-R – Color of receptacles shall be red.
   f. Receptacles installed on the exterior of the Building shall be “Weather Resistant” Type.
6. USB Charger Devices shall be as follows, or as manufactured by Hubbell, or equal:
   a. 20 amp, 2 USB chargers and duplex tamper resistant receptacle (3.0 amp) – USB20X2W.
   b. 20 amp, 4 USB charger receptacle (5.0 amp) – USB4W.
7. Color of receptacles shall be white, unless otherwise noted.

2.9 WIRING DEVICE PLATES

A. All device plates shall be Specification Grade, .032” thick, Type 430, stainless steel, brushed finish. Plates shall be of appropriate type and size for all wiring and control devices.

B. Plates shall be set so that all edges are in contact with the mounting surface. Plaster fillings will not be allowed. Multi-device locations shall have one common device plate.

C. Nameplate designation for device plates shall be engraved directly on plates and filled in black.

D. Device plates shall be by the same manufacturer as devices.

E. All receptacle device plates for circuits other than 120V, 2 wire, shall be engraved with 1/4” high letters, filled black, indicating voltage characteristics of the outlet.

F. Plates for surface type boxes shall not overlap boxes and shall be designed for use with surface boxes.

G. Device plates for circuits connected to the emergency distribution system shall have engraved nameplates marked “Emergency Circuit,” 1/4” high letters, filled in black.

H. Device plates for weatherproof receptacles shall be clear Polycarbonate “In-Use” type, pad lockable.

2.10 LIGHTING FIXTURES

A. Furnish all labor, materials and equipment required for a complete installation of lighting equipment specified on the lighting fixture schedule. This shall include plaster frames for all recessed fixtures whether or not itemized or specified on lighting fixture schedule which appears on Drawings.

B. Electrical Subcontractor shall assume all responsibility for the safe handling of all lighting fixtures which are furnished under this Section and other accessories and lamps until the final inspection has been made by the Architect.

C. Special fittings and materials that may be required to support fixtures shall be supplied as well as supports or grounds required to secure surface or pendant mounted fixtures on suspended ceilings unless otherwise noted. Fixtures shall be supported from the Building structure, and shall be independent of ducts, pipes, ceilings and their supporting members. This support shall be in addition to regular fixture support bars, and saddles. Fluorescent fixtures mounted in association with suspended or integrated ceiling systems shall be supported above ceiling by threaded 1/4” diameter continuous galvanized steel hanger rods or #12 jack chain. Each such fixture shall have two supports per fixtures. Where duct work, pipes, type of Building construction materials and structural framing members provide obstructions or difficult support means, hanger rods shall be used in association with horizontal sections of steel support channels in an approved manner. Steel support channels shall be Unistrut, Kindorf, Huskey Products, or equal. Rigid steel conduit may be used instead of steel support channels for size and method of support. Exact mounting height of all stem supported lighting fixtures shall be determined on the job by Architect.

D. Ballasts for fluorescent fixtures shall be the series type, classified for sound rating A, be CBM rated and shall have automatic resetting thermal protection as per latest Class P requirements as set forth by Underwriters Laboratories, 800 m.A. ballasts shall be sound rated Class B, and 1,500 m.A. ballast shall be a minimum sound rating of Class C.

E. Ballasts shall be of the normal power factor type unless otherwise noted. Proper ballast shall be furnished and installed for all lighting fixtures normally designed for operation with ballasts, whether or not such ballasts are specifically itemized on fixture schedule. This shall include not only fluorescent type fixtures but also all other fixtures employing high intensity discharge lamps.

F. Ballasts for fluorescent or other high intensity discharge lamps used outdoors shall be of the low temperature type, designed for operation down to a temperature of minus 20 degrees F.

G. If fluorescent fixtures operate improperly due to overheating, Electrical Subcontractor shall furnish and install ballast heat radiators to alleviate the condition, at no cost to the Owner.

H. Furnish and install a complete set of new lamps for all fixtures. Lamps shall be General Electric, Philips, or Osram/Sylvania. The Electrical Subcontractor shall furnish to the Owner, at the completion of the project, spare lamps equal to 10% of the installed quantity for each type of lamp installed.

I. Fixtures, part or parts thereof (including lamps) determined defective upon completion of electrical installation shall be replaced by Electrical Subcontractor, at no cost to Owner.

J. Consult with General Contractor regarding arrangement of framing members to permit centering of recessed fixtures.

K. Consult with ceiling Subcontractor and coordinate fixture locations and supports with suspended ceiling system.

L. Electrical Subcontractor shall be responsible for furnishing the specified recessed fixtures with proper mounting arrangement to be compatible with the type of ceiling construction in which fixture is to be mounted. If necessary, the type mounting arrangement shall be changed from that specified or indicated on fixtures schedule to conform to this requirement, at no additional cost to Owner. Submission of Shop Drawings of such recessed fixtures shall be interpreted to indicate that Electrical Subcontractor has verified ceiling construction, type and material with the Architect for the various areas of the project in which these fixtures shall be mounted. Shop Drawings of such fixtures shall be accompanied by a written statement indicating Electrical Subcontractor has verified such mounting arrangements with Architect and the date verified.

M. All suspended lighting fixtures shall be hung in association with improved aligner type hangers, except where noted.

N. In addition to fixture supports, surface mounted lighting fixtures shall be secured to surface which they mount at a minimum of two points on fixture housing to prevent rotation or movement of fixture out of its normal position of alignment.

O. After installation and lamping of permanent lighting fixtures and with approval of the Architect, these fixtures may be used for lighting, and will not require re-lamping prior to completion of project, except where lamps are faulty or burnt out.

P. Lamping color temperature shall be 3500°K for interior lighting fixtures, unless otherwise noted.

Q. Lamping color temperature shall be 4100°K for exterior lighting fixtures, unless otherwise noted.

R. Lamps which are to be dimmed shall be provided with minimum 100 hours of burn in time; Electrical Subcontractor shall not install lamps in dimmable lighting fixtures until this process is completed.

S. Lighting fixtures with multi wattage ballasts and drivers shall be labeled from the factory for the wattage specified to ensure compliance with Energy Code calculations.

T. All lighting fixtures that utilize LED (light emitting diodes) lamp sources shall be Energy Star rated or DLC (Designlights Consortium) qualified product listed, a kelvin temperature as scheduled having a color rendering index of 80 minimum and minimum L70 lifetime rating of 50,000 at 25°C ambient. LED array and driver packages shall have published IESNA LM-79 and LM-80 testing data as a standard manufactured offering. Individual component testing will not be accepted. LM-79 must be conducted at a laboratory listed in the U.S. Department of Energy's LED Lighting Facts approved testing laboratories list. Testing must be conducted within the accreditation effective and expiration dates detailed for a given laboratory. In-house LM-80 reporting of LED array from LED manufacturer will be accepted.

U. Where lighting fixtures other than the specified products are provided, the contractor shall provide light level calculations in accordance with IESNA standards to justify that substituted fixtures are of equal performance to the specified products (applies to all lighting fixtures in all spaces).

2.11 ELECTRICAL SUPPORTING DEVICES

A. All conduit and fittings on all work are to be secured by one or more of the following:
   1. Masonry - metal clips secured by toggle bolts or lead expansion sleeves.
   2. Woodwork - metal clips secured by wood screws.
   3. Bar joists - wedge hangers.
   4. Flanged beams - flange clips.

B. All pipe hangers and equipment supports shall be constructed and installed in accordance with Seismic Zone requirements as outlined in the State Building Code. This Contractor shall submit one (1) copy of Shop Drawings and calculations detailing seismic hanger restraints to the local Building Authority and Architect, along with a letter of compliance signed by a registered structural engineer confirming that the piping hangers meet State Seismic Code requirements. Cable provided for seismic systems shall be color-coded and pre-stressed.

2.12 DISCONNECT SWITCHES

A. The Electrical Subcontractor shall furnish and install disconnecting means to comply with the National Electrical Code for all motors. Disconnect switches shall be fused or unfused as shown on the Drawings, NEMA Type HD safety switches for heavy duty, with interlocking cover, side operated with provisions for padlocking the switch handle in the off position.

B. All motor isolating switches indicated on the Drawings shall be rated in horsepower, and shall be rated for the voltage of the motor and shall be furnished and installed at the motor location whether or not the motor is within sight of the motor feeder disconnecting means.

C. Disconnect switch enclosures shall be of the proper NEMA type for the intended location as defined by NEMA and shall be phosphate coated or equivalent code gauge galvanized sheet steel with USAFI No. 24 dark gray baked enamel finish.

D. Disconnect switches shall bear the Underwriters' Laboratories label and be

manufactured by Square D Company, Eaton/Cutler-Hammer, Siemens, or equal.

2.13 FUSES

A. General

1. Furnish and install a complete set of fuses for all fusible equipment on the project as specified by the Electrical Drawings. Final tests and inspection shall be made prior to energizing the equipment. This shall include tightening all electrical connections and inspecting all ground conductors. Fuses shall be as manufactured by Mersen, Cooper Bussman, and Littelfuse, or equal.

B. Mains, Feeders and Branch Circuits

1. Fused circuits rated 601 amperes and above shall be protected by current-limiting Class L A4BQ fuses. Fuses shall be time delay and shall hold 500% of rated current for a minimum of 4 seconds, clear 20 times rated current in .01 seconds or less and be UL listed and CSA certified with an interrupting rating of 200,000 RMS symmetrical amperes.
2. Fused circuits rated 600 amperes or less shall be protected by current-limiting Class RK1 time delay A2D (250V) or A6D (600V) or Class J time delay AJT fuses. Fuses rated 8 amperes and above shall have the Smart Spot blown fuse indicator. This indicator shall provide guidance for ascertaining if the opening was caused by an overload or a short circuit. No holes are permitted in the fuse body for the indicator function. Fuses shall hold 500% of rated current for a minimum of 10 seconds (30A, 250V Class RK1 case size shall be a minimum of 8 seconds) and shall be UL listed and CSA certified with an interrupting rating of 200,000 RMS symmetrical amperes.
3. Metal end caps of fuses rated 61 through 600 amperes shall be electrically connected to the fuse blades to facilitate safe voltage testing during OSHA required LOTO (lock out/tag out) procedures.

C. Motors and Motor Controllers

1. Motor Protection

a. All individual motor circuits shall be protected by Class RK1, Class J, or Class L time delay fuses.

- Motors under 10 H.P. ATDR fuses (Class CC) may be used on motors rated less than 10 H.P. at 480VAC and rated less than 5 H.P. at 240VAC. Fuse holders for Class CC fuses shall incorporate blown fuse indication.

b. Fuse sizes for motor protection shall be chosen from tables published for the appropriate fuse. Heavy load and maximum fuse ratings are also shown for applications where typical ratings are not sufficient for the starting current of the motor.

APPLICATION INFORMATION

LOW VOLTAGE FUSES FOR MOTOR PROTECTION

Three Phase Motor Fuse Selection UL Classes RK5, RK1, J, CC and L

MOTOR HP	FULL LOAD AMPERES	RECOMMENDED FUSE AMPERE RATING MOTOR ACCELERATION TIMES								
		MINIMUM 2 SECS.	TYPICAL 5 SECS.	HEAVY LOAD OVER 5 SECS.	MINIMUM 2 SECS.	TYPICAL 5 SECS.	HEAVY LOAD OVER 5 SECS.	MINIMUM 2 SECS.	TYPICAL 5 SECS.	HEAVY LOAD OVER 5 SECS.
460V		RK5–TRS (Tri-onic®)/RK1–A6D			J–AJT			UL CLASS CC ATDR		
1/2	1.1	1-4/10	1-6/10	2	1-1/2	1-6/10	2	3	3-1/2	4-1/2
3/4	1.6	2	2-1/4	2-8/10	2	2-1/4	2-8/10	3-1/2	5	6-1/4
1	2.1	2-1/2	3-2/10	4	2-1/2	3-2/10	4	5	6-1/4	9
1-1/2	3	3-1/2	4-1/2	5-6/10	3-1/2	4-1/2	5-6/10	6	9	12
2	3.4	4	5	6	4	5	6	8	10	12
3	4.8	5-6/10	7	9	6	8	9	12	15	17-1/2
5	7.6	10	12	15	10	12	15	15	25	30
7-1/2	11	15	17-1/2	20	15	17-1/2	20	25	30	-
10	14	17-1/2	20	25	17-1/2	20	25	30	-	-
15	21	25	30	40	25	30	40	-	-	-
20	27	35	40	50	35	40	50	-	-	-
25	34	40	50	60	40	50	60	-	-	-
30	40	50	60	70	50	60	70	-	-	-
40	52	70	80	100	70	80	100	-	-	-
50	65	80	100	125	80	100	125	-	-	-
60	77	100	125	150	100	125	150	-	-	-
75	96	125	150	175	125	150	175	-	-	-
100	124	175	200	225	175	200	225	-	-	-
125	156	200	225	300	200	225	300	-	-	-
150	180	225	250	350	225	250	350	-	-	-
200	240	300	350	450	300	350	450	-	-	-
250	302	400	450	600	400	450	600	-	-	-
300	361	450	600	-	450	600	-	-	-	-
		CLASS L–A4BT								
300	360	–	601	650						
400	477	–	800	900						
500	590	–	1000	1100						

Minimum - This sizing is recommended if motor acceleration times do not exceed 2 seconds. Minimum sizing with RK1, RK5, and Class J fuses will provide overload relay back up protection but may not coordinate with some NEMA Class 20 overload relays. Minimum sizing is generally not heavy enough for motors with code letter G or higher.

Typical - Suggested for most applications. Will coordinate with NEMA Class 20 overload relays. Suitable for motor acceleration times up to 5 seconds.

Heavy Load - Maximum fuse size in accordance with Table 2. If this fuse size is not sufficient to start the load, RK1, RK5, and J time delay fuse size may be increased to a maximum of 225% of full load amperes. Class CC fuses may be increased to 400% of full load amperes. The Heavy Load column should be used for Design E and high efficiency Design B motor fuse sizing.

2. Motor Controllers

   a. IEC style and NEMA style motor controllers shall be protected from short circuits by time delay fuses. Controllers and fuses shall be coordinated for Type 2 protection of the motor controllers based upon the motor controller manufacturer's published recommendations. The fuses shall be Class RK1 A2D (250V) or A6D (600V) or Class J AJT, Class CC ATDR or Class L A4BQ.

3. AC and DC Variable Speed Drives

   b. AC and DC drives not internally protected by high speed fuses shall be provided branch circuit protection by High Speed Class J (HSJ) fuses. Class J time delay AJT fuses are an acceptable alternative to the HSJ in by-pass applications.

4. Motor Control Centers
   a. To minimize arc flash incident energy, MCC's shall have fusible mains and maximum fuse ratings shall be as follows:

      - A4BQ1200 for bolted fault currents greater than 40,000A
      - A4BQ800 for bolted fault currents greater than 16,000A
      - AJT600 for bolted fault currents greater than 14,000A
      - AJT400 for bolted fault currents greater than 5,000A

      Unit inserts (buckets) shall be fusible and protected by current-limiting Class J time delay (AJT) or Class RK1 time delay (A2D, A6D) fuses selected for Type 2 protection of the motor controllers based upon the motor controller manufacturer's published recommendations.

D. Other Equipment
   1. Lighting and control circuits rated 600VAC and less shall be protected by Class CC time delay ATDR or ATQR fuses, sized according to the Electrical Drawings.
   2. Switchboards, panelboards, and load centers shall utilize fully rated and listed components. Series rated overcurrent protective devices are not acceptable.

E. Labeling
   1. Industrial control panel labels shall include a SCCR (short circuit current rating) and shall specify the overcurrent protection device upon which this rating is based as per the National Electrical Code.
   2. Switchboards, panelboards, industrial control panels, and motor control centers shall include a label warning qualified personal of the potential arc flash hazard. The label shall be visible with equipment door closed.

F. Spares
   1. Spare fuses amounting to 10 %(minimum three) of each type and rating shall be supplied. These shall be turned over to the Owner upon project completion. Fuses shall be contained and cataloged within the appropriate number of spare fuse cabinets (no less than one), located per project Drawings. Spare fuse cabinets shall be equipped with a key lock handle, be dedicated for storage of spare fuses and shall be ATFC.

G. Execution
   1. To prevent mechanical damage to fuses; main, feeder, and branch circuit fuses are to be removed from equipment during transit and re-installed when equipment is to be energized.
   2. As installed Drawings, showing actual fuses installed, shall be submitted to the Engineer after completion of the project.
   3. Fuseholders capable of accepting Class H fuses are not acceptable.

H. Substitution
   1. Fuse sizes indicated on Drawings are based on fuse performance and selectivity ratios. Alternative submittals to furnish materials other than those specified shall be submitted to the Engineer along with short circuit, selective coordination, and arc flash hazard studies.

2. Performance of any fuses submitted for substitution shall have:
   a. Indication integral with the fuse so that it indicates the voltage transient when the fuse is opened. This is a relative measure of how severe the fault was and gives information to the maintenance people to make them more efficient. No holes are permitted in the fuse body for the installation of indicators.
   b. Only the listed UL categories must be used, in order to reduce the possibility of arc flash injuries. Class RK5 and Class H are prohibited and could cause major liability should an arc flash occur.
   c. All end-caps of fuses must be electrically connected to the fuse blades to prevent misreading of electrical testers during the required OSHA LOTO (Lock-Out Tag-Out) procedures. Misreading on the LOTO final voltage check could cause hazardous shock.

2.14 STARTERS

A. Motor starters shall be furnished and installed by this Contractor except as noted otherwise in other Sections of this Specification.

B. All motor starters shall be of the maintained contact type and have individual running overload protection in each phase and shall be provided with two sets of auxiliary contacts (one normally open and one normally closed).

C. Starters shall be of size and type required for the particular motor horsepower and voltage.

D. Locate starters adjacent to panel feeding same unless otherwise indicated on the Drawings.

E. Manual starters shall be of the toggle mechanism type for full voltage starting.

F. Magnetic starters shall be across-the-line type, with means for remote control, except maintained contact type starters shall be used only where noted for specific items of equipment.

G. All starters shall have overload reset button, pilot light to indicate on or off and hand-off-auto switch in cover unless otherwise indicated.

H. Starters shall be furnished in the enclosures called for on the Drawings and shall be grouped whenever possible.

I. Motor starters, where grouped, shall be mounted on a new 3/4” thick exterior grade plywood mounting board finished to match starter enclosures.

J. All starters and remote control stations furnished under this Section shall have laminated plastic engraved nameplates designating the equipment controlled. Letters shall be 1/4” high.

K. Motor starters and controls shall be Square D, General Electric, Siemens, or equal.

L. All magnetic starters furnished under this Section which are connected to circuits operating at more than 120V shall have built-in control transformers with 120V secondary control supply.

M. Thermal trips for all motor starters supplied under this Section shall be ambient temperature compensated.

2.15 THERMAL SWITCHES

A. Thermal switches shall be NEMA Type 1 toggle switch for normal duty with thermal overload relay. Switch enclosures shall be of a type approved for the location and atmosphere in which it is mounted. Thermal switches shall be installed where called for or where required by Code. Thermal switches shall be provided with pilot where called for on the Drawings.

B. Thermal switches shall be as manufactured by Square D, Eaton, Siemens, or equal.

2.16 ACCESS PANELS

A. Provide access panels for access to concealed junction boxes and to other concealed parts of system that require accessibility for operation and maintenance. In general, electrical work shall be laid out so access panels are not required.

B. Access panels shall be located in a workmanlike manner in closets, storage rooms, and/or other non-public areas, positioned so that junction can be easily reached and size shall be sufficient for purpose (minimum size 12” x 16”). When access panels are required in corridors, lobbies, or other habitable areas, they shall be located as directed by the Architect.

C. Access panels shall be as specified under Section 08 31 00, Access Panels and Doors.

2.17 DRY TYPE TRANSFORMERS

A. Transformers shall have separate primary and secondary windings. Transformers shall be UL listed insulation systems of 220 degrees C., with 150 degrees C. temperature rise above 40 degrees C. ambient, except sizes less than 10 KVA may be 185 degrees C., UL listed insulation system with 150 degrees C. temperature rise above an ambient of 40 degrees C. Transformers larger than 10 KVA shall be of ventilated type.

B. Core and coil assembly shall be supported from the enclosure base and shall have sound insulation pads between core and coil assembly and the enclosure base. KVA and voltage ratings shall be as indicated on Drawings.

C. Transformers shall be designed for natural draft cooling conforming to applicable ANSI and IEEE Standards. Six 2-1/2% full capacity taps shall be provided, two above and four below rated voltage. Noise level shall not exceed 45DB on 15 to 50 KVA, 50DB on 51 to 150 KVA transformers and 55 DB on transformers over 150 KVA.

C. Connection to transformers shall be made with liquid- tight flexible conduit with grounding conductor. Transformers shall be installed in association with Korfund vibration isolation pads to reduce noise level to a minimum. Refer to schedule on Drawings for mounting arrangement. Transformers shall be manufactured by Square D, Cutler-Hammer, Siemens, or equal.

2.18 EMERGENCY STANDBY SYSTEM (SCHOOL)

A. Furnish and install a complete and operating emergency power system as specified herein and as indicated on the Drawings.

B. The system shall be arranged to provide automatic and instantaneous power upon loss of normal power. This system shall meet all Code requirements for emergency lighting and power.

C. Furnish complete, install and leave in good running condition a 1000 KW diesel fueled engine driven generating set continuously rated for standby service. The KW rating shall be continuously available during any power outage. The unit shall be as hereinafter described and as shown on the Drawings, complete with all controls, attachments, accessories, fuel and exhaust systems.

D. The unit shall be the product of a manufacturer regularly engaged in the production of this type of equipment as manufactured by Kohler Company, Caterpillar Corporation, Onan Corporation or equal.

E. The unit shall be capable of accepting the incoming loads of the Automatic Transfer Switches.

F. Operation:
1. The operation of this unit shall be automatic and upon the closing of a remote starting contact in Automatic Transfer Switch, the engine shall start and attain rated voltage and frequency within ten (10) seconds.
2. All necessary accessories shall be provided to assure starting within the time described above under the ambient conditions described herein.
3. Furnish and install all electrical work and equipment required for the proper operation of this system. The General Contractor will provide the necessary structured supports for the emergency generator. The Electrical Subcontractor shall provide weight information, as well as dimensional information of the generator to the General Contractor, prior to installing the supports, if necessary.

G. Emissions;
1. The proposed generator set shall be EPA Tier 3 Certified and in compliance with the Commonwealth of Massachusetts Emission regulations at the time of installation/commissioning. Actual engine emissions values must be in compliance with EPA Tier 2 emissions standard per ISO 8178 – D2 Emissions Cycle at specified ekW/bHP rating. Utilization of the “Transition Program for Equipment Manufacturer’s” also known as “Flex Credits” to achieve Tier 3 certification is not in compliance with MA Regulations “310 CMR 7.02 U Plan Approval and Emission Limitations” and will not be accepted.

H. Engine:

1. The engine shall be unit-mounted radiator cooled, 4 cycle, industrial type, heavy duty, diesel fueled, with a minimum displacement of 1,959 cubic inches, and a maximum RPM of 1800. Ratings shall be for standard conditions of 29.92 barometer and 60 degrees air temperature.
2. Lubrication shall be a full pressure system using an engine driven gear-type lube oil pump with replacement element full flow lube oil filter. Oil cooler shall be required.
3. Base Mounted Fuel Tank:
   There shall be a double wall diesel fuel storage tank and rupture alarm supplied as an integral part of the base of the unit. The tank shall be furnished and constructed in accordance with Commonwealth of Massachusetts and City requirements for fuel storage. The fuel tank shall be installed in the generator manufacturer's factory and all fuel connections, vents, returns and fills shall be installed and tested prior to shipment. Field or dealer installed tank installations are not acceptable. Tank shall be sized to provide 48 hours of run time, at 100% load.

   The fuel tank shall meet all CMR 527 and Board of Fire Preventions Regulations and be accompanied with approval seal.

   This installation shall include but shall not be limited to the following:
   -Double wall steel fuel tank of the rated capacity
   -Enlarged steel skid base
   -Fuel lines including supply, return and vent lines
   -Fuel fill
   -Fuel level gauge
   -Low fuel warning float switch
   -Rupture basin and alarm
   -Low fuel level alarm relay

   All required appurtenances recommended or required by the manufacturer for a complete and correct installation shall be supplied and the entire assembly shall be factory primed and painted in the manufacturer’s standard color to protect against corrosion.
4. Diesel Fuel System
   a. The engine fuel system shall include all equipment normally supplied and recommended by the generator set manufacturer for standby generator service. The fuel engine system equipment shall include (but not be limited to) the following:
      -fuel injection system
      -fuel line solenoid valve
      -flexible fuel connections
5. Governor:
   a. The engine shall be equipped with a isochronous governor capable of +/- 0.25% steady-state frequency regulation.
6. Starting System:
   a. The engine shall have a 24 V.D.C. starting system with 24 volt positive engagement solenoid shift starting motor and 35-ampere minimum automatic battery charging alternator with solid state regulation.
   b. Batteries - One set of starting batteries with cables and steel battery rack, shall be included, capable of delivering the manufacturer's recommended minimum cold-cranking amps

required at 0°F, per SAE Standard J-537.

c. Float type battery charger shall be supplied to maintain the starting batteries at full charge. The charger shall be a 10-ampere automatic float and equalize battery charger with +/- 1% constant voltage regulation from no load to full load over +/- 10% AC input line variation, current limited during engine cranking and short circuit conditions, temperature compensated for ambients from -40°C to +60°C, 5% accurate voltmeter and ammeter, fused, reverse polarity and transient protected. Alarm circuit board to meet the requirements of NFPA 110 for low battery voltage, high battery voltage, and battery charger malfunction shall be provided.

d. There shall be a belt driven battery charging alternator with regulator and charge rate ammeter for charging the batteries while the engine is running or the float type battery charger may be arranged to charge the batteries from the normal source when the engine is shut down and from the generator output when the generator is operating. This shall be accomplished by a relay energized from the generator output.

7. Jacket Water Heater:

a. An engine jacket water heater shall be provided to maintain the engine jacket at a temperature high enough to assure starting the engine and attaining rated voltage and frequency within ten (10) seconds. The jacket water heater shall be of the capacity recommended by the generator set manufacturer to meet the above conditions. Input to the voltage heater shall be 208 volt, single phase.

8. Safety Shutdown:

a. The engine shall be equipped with safety contacts for:
-Low lube oil pressure
-High jacket water temperature
-Overspeed
-Overcrank

9. Engine Instruments:

a. The following engine instruments shall be connected either in an engine instrument panel or in the generator control panel:
-Lube oil pressure
-Water temperature
-D.C. ammeter
Any other instruments considered necessary by the manufacturer shall be included.

10. Exhaust System:

a. A critical grade exhaust silencer suitable for residential type silencing complete with condensate drains shall be supplied of the size recommended by the generator set manufacturer, but in no case less than 4 inches. Silencer shall be as manufactured by Kettell, Maxim or Burgess Manning. An octave band center frequently in Hertz data sheet shall accompany all muffler shop Drawings. A section of seamless, flexible stainless steel exhaust connection of the size and type recommended by the generator set manufacturer, but in no case less than 4-inch diameter and eighteen (18) inches long shall be supplied. If the engine is Vee type, a single exhaust outlet header shall be supplied. The

generator stack shall comply with 310 CMR 7.26 (42). Stack height shall be a minimum of 10'-0" above the emergency generator weather housing. For emergency generators rated 1MW and above, the stack shall be 1.5 times the height of the height to the top of the generator enclosure. Manufacturer to verify required height to meet 310 CMR 7.26 (42).

11. Mounting:
    a. The engine and generator shall be close coupled and mounted on a structural steel base designed to maintain proper alignment of the unit.
    b. The unit shall be certified by the manufacturer to be free from any critical torsional vibrations within a range of plus or minus 10% of synchronous speed.
    c. Vibration isolators of the type shall be supplied with the unit. The number of isolators shall be as recommended by the generator set manufacturer.

I. Generator:
1. Rating - 1000 KW, 1250 KVA, 0.8 P.F., 3 phase, 60 cycle, 480/277 volts.
2. Type - Revolving field, 4 pole, single bearing, drip-proof.
3. Exciter - Brushless, direct connected, fully tropicalized, SCR rectifiers, static voltage regulator, rheostat, excellent motor starting capability.
4. Voltage Regulation - Plus or minus 1% of any preset value over the three (3) phase load range. Instantaneous voltage dip or rise, when measured with an oscilloscope, will not exceed 20% upon full load applications or rejection, and will return to preset value within 0.5 seconds.
5. Waveform - Deviation factor of output voltage will not exceed 5% and the value of any individual harmonic will not exceed 2% of the fundamental when operating with an unbalanced load.
6. Temperature Rise - Temperature rise of any component will not exceed the rise permitted by NEMA standards.
7. Rotor - One (1) piece laminations welded and secured to shaft by a key and press fit. Armortisseur windings installed and connected between poles as an aid to parallel operation and improved waveform during unbalanced loads. Field coils machine would on insulated pole body and securely braced. Rotor statically and dynamically balanced.
8. Stator - One (1) piece laminations welded together. Stator coils form wound and placed in insulation slots. Stator pressed and welded in a rigid steel frame.
9. Bearing - Double sealed ball bearing, lubricated for life.
10. Insulation - NEMA Class F insulation.
11. Varnish - Three (3) coats modified polyester type, will not support fungus growth.
12. Cooling - Cast aluminum fan mounted on generator shaft.
13. Radio Suppression - Radiated or conducted radio interference will not affect normal commercial apparatus.
14. Controls:
    a. Unit Mounted - The engine generator set shall include a combination engine generator control panel shock mounted at the generator end of the unit. This unit mounted panel shall include (but not be limited to) the following:
    -Water temperature gauge
    -Oil pressure gauge

-D.C. battery charge rate ammeter
-A.C. voltage regulator
-Voltage adjusting rheostat
-Start-stop switch
-A.C. voltmeter
-A.C. ammeter with current transformers
-Combination VM-AM phase selector switch
-Frequency meter
-Elapsed time meter
-Automatic start stop control with:
overcrank protection (manual reset)
high water temperature
overspeed
overcrank
selector switch - “off,auto,manual”
-Common failure relay (wire to fire alarm control panel as trouble alarm)
-Manual reset line circuit breakers as indicated on Drawings furnished with generator, 277/480 volts. Mounted in NEMA 1 enclosures with interrupting capacity of 65,000 amps symmetrical. Circuit breakers which are rated at 1200 amps or more shall have Arc Energy Reduction complying with National Electrical Code 240.87. Fully Rated equipment shall be provided; Series Rated equipment is not acceptable.

b. The control shall be designed to start the engine upon a closure of a remote contact, arm all safeties, and shutdown the engine when the remote contact is reopened.

c. The control must be manually reset following any fault condition.

d. Control power shall be from the engine start battery.

J. Annunciator Panel:

1. A remote mounted engine generator annunciator panel shall be built, tested and supplied by the generator supplier. The annunciator panel shall monitor, visually and audibly, the following:
-Alarm Silence
-Generator Test
-Line Power
-Generator Power
-System Ready
-Alarm Switch off
-Generator Switch off
-Overcrank
-Low Battery Voltage
-High Battery Voltage
-Overspeed
-Emergency Stop
-Low Oil Pressure
-High Water Temperature
-Low Fuel
-Low Water Temperature
-Approach Low Oil Pressure
-Approach High Water Temperature
-Main Tank Rupture

K. Automatic Load Transfer Switches:

1. Automatic transfer switches shall be furnished with full load current rating as indicated on Drawings, 277/480 volts, 3 phase, 4 wire, 4 pole, 60 Hertz, A.C. normal and emergency. Minimum AIC rating shall be 65,000. The transfer switches shall be capable of switching all classes of load, and shall be rated for continuous duty when installed in a non-ventilated enclosure that is constructed in accordance with Underwriters' Laboratories, Inc., standard UL-1008. Emergency loads (ATS-2) shall be Step 1, while Optional Standby loads (ATS-1) shall be Step 2.
2. The transfer switches shall be double throw, actuated by a single electrical operator momentarily energized; and connected to the transfer mechanism by a simple overcenter type linkage with a total transfer time not-to-exceed one-half (1/2) second. The transfer switches shall be capable of transferring successfully in either direction with 70% of rated voltage applied to the switch terminals.
3. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically locked in position without the use of hooks, latches, magnets, or springs; and shall be silver-tungsten alloy protected by arcing contacts, with magnetic blowouts on each pole.
4. The transfer switches shall be equipped with a manual operator that is designed to prevent injury to the operating personnel, if the electrical operator should suddenly become energized during manual transfer. The manual operator shall provide the same contact-to-contact transfer speed as the electrical operator to prevent a flash-over from switching the main contacts slowly.
5. The transfer switches shall be equipped with an elevator pre-signal contact.
6. Engine starting contacts shall be provided to start the generating plant, if any phase of the normal source drops below 70% of rated voltage, after an adjustable time delay period of three (3) to thirty (30) seconds, to allow for momentary dips. The transfer switches shall transfer to emergency, as soon as the voltage and frequency have reached 90% of rated voltage. After restoration of normal power on all phase to 90% of rated voltage, an adjustable time delay period of 0-30 minutes shall delay re-transfer to normal power, until it has had time to stabilize. If the emergency power source should fail during the time period, the time delay shall be by-passed, and the switches shall return immediately to the normal source. After the switches have retransferred to normal, the engine generator shall be allowed to operate at no load for an adjustable period of time (0-5 minutes) to allow it to cool before shutdown. The transfer switches shall include a test switch to simulate normal power failure pilot lights on the cabinet door to indicate the switch closed on normal or emergency and four (4) auxiliary contacts on the main shaft; two (2) closed on normal, the other two (2) closed on emergency. Included engine exerciser with 0-168 hours timer.
7. Load transfer switches shall be as manufactured by Russelectric, ASCO, Westinghouse, or equal.
8. Provide two hour rated stop/start circuit from generator to all automatic transfer switches.

L. Test:

1. The supplier of the equipment shall provide at no additional charge, any information or supervision required for the proper installation of the equipment. Upon completion of the installation of this unit, a test run of four hours shall be conducted by the equipment manufacturer's factory trained serviceman in the presence of the City Electrical Inspector. Using load banks to test full generator KW, at this time adjustments shall be made for correct operation of the equipment and the following readings taken at 15-minute intervals.
   -Engine jacket water temperature
   -Generator temperature
   -Oil pressure
   -Battery charge rate
   -A.C. volts
   -A.C. amps (all legs)
   -Engine air exhaust temperature
   -Engine oil temperature
2. The unit test shall also be made by utilizing available connected load. The supplier of this equipment shall also furnish and install lube oil in the engine and also drain and refill the engine with new lube oil after the engine-generator test has been completed. If the engine-generator unit should fail this initial test run, as determined by the representative of the Owner, after proper corrective measures have been implemented, replace engine lube oil again after the second test. If any additional tests are required to prove the performance of the engine-generator unit, lube oil shall be replaced after each test run.
3. Prior to shipment of generator to the job site, conduct a 3-hour full load shop test utilizing inductive load to attain full rated load. A written report of this test shall be forwarded to the Engineer for approval prior to shipment. All expense for these tests shall be carried by the Electrical Subcontractor.
4. A power outage test will be conducted by the Electrical Subcontractor, witnessed by the Commissioning Agent, using the Building load when all systems are completed. Electrical Subcontractor shall demonstrate proper operation of the emergency system to supply power to all emergency equipment during the simulated power outage and return back to normal utility service.
5. The Electrical Subcontractor shall pay for all fuel required for testing and shall leave the fuel tank full of fuel and the radiator full of antifreeze at the completion of testing and acceptance of the emergency generator.

M. Weather Housing

1. Weather housing shall be constructed of a minimum 16 gauge steel material. Fixed louvers shall be installed front and back to prevent blowing snow or rain from entering the housing. Roof shall have a crease down the length to prevent water from standing. Roof shall be braced, if necessary, to support the weight of silencer. Side panels and rear panels shall be lockable and removable for access to junction box. Locks must be heavy duty. Housing shall be free of any manufacturer’s stickers and logos.
2. The enclosure shall be fabricated and mounted by the generator set manufacturer so as to insure compatibility of all systems. Seller-installed enclosures and enclosures provided by other than the manufacturer of

the generator will not be acceptable. The complete assembly shall be factory finished and painted inside and out in the standard color of the manufacturer to help prevent against weathering and corrosion and to maintain an aesthetically pleasing appearance.

3. The enclosure shall be completed lined with a sound installation barrier. This barrier must be not less than 1" thick and have a minimum density of 2 lbs./3 cu. ft. In addition, material must meet UL-94 classification HF-1. This material is intended to absorb airborne noise within the enclosure.
4. The enclosure shall be sized such that all accessories specified herein including but not limited to:
   -Engine/Generator
   -Jacket heaters
   -Batteries
   -Battery charger
   -Base fuel tank
   -Exhaust
   -Line circuit breakers shall be housed within the enclosure.

2.19 EMERGENCY STANDBY SYSTEM (NEW WASTE WATER TREATMENT FACILITY)

A. Furnish and install a complete and operating emergency power system as specified herein and as indicated on the Drawings.

B. The system shall be arranged to provide automatic and instantaneous power upon loss of normal power. This system shall meet all Code requirements for emergency lighting and power.

C. Furnish complete, install and leave in good running condition a 150 KW diesel fueled engine driven generating set continuously rated for standby service. The KW rating shall be continuously available during any power outage. The unit shall be as hereinafter described and as shown on the Drawings, complete with all controls, attachments, accessories, fuel and exhaust systems.

D. The unit shall be the product of a manufacturer regularly engaged in the production of this type of equipment as manufactured by Kohler Company, Caterpillar Corporation, Onan Corporation or equal.

E. The unit shall be capable of accepting the incoming loads of the Automatic Transfer Switches.

F. Operation:
   1. The operation of this unit shall be automatic and upon the closing of a remote starting contact in Automatic Transfer Switch, the engine shall start and attain rated voltage and frequency within ten (10) seconds.
   2. All necessary accessories shall be provided to assure starting within the time described above under the ambient conditions described herein.
   3. Furnish and install all electrical work and equipment required for the proper operation of this system. The General Contractor will provide the necessary structured supports for the emergency generator. The Electrical Subcontractor shall provide weight information, as well as dimensional information of the generator to the General Contractor, prior to installing the supports, if necessary.

G. Emissions;

1. The proposed generator set shall be EPA Tier 3 Certified and in compliance with the Commonwealth of Massachusetts Emission regulations at the time of installation/commissioning. Actual engine emissions values must be in compliance with EPA Tier 2 emissions standard per ISO 8178 – D2 Emissions Cycle at specified ekW/bHP rating. Utilization of the "Transition Program for Equipment Manufacturer's" also known as "Flex Credits" to achieve Tier 3 certification is not in compliance with MA Regulations "310 CMR 7.02 U Plan Approval and Emission Limitations" and will not be accepted.

H. Engine:

1. The engine shall be unit-mounted radiator cooled, 4 cycle, industrial type, heavy duty, diesel fueled, with a minimum displacement of 1,959 cubic inches, and a maximum RPM of 1800. Ratings shall be for standard conditions of 29.92 barometer and 60 degrees air temperature.
2. Lubrication shall be a full pressure system using an engine driven gear-type lube oil pump with replacement element full flow lube oil filter. Oil cooler shall be required.
3. Base Mounted Fuel Tank:

   There shall be a double wall diesel fuel storage tank and rupture alarm supplied as an integral part of the base of the unit. The tank shall be furnished and constructed in accordance with Commonwealth of Massachusetts and City requirements for fuel storage. The fuel tank shall be installed in the generator manufacturer's factory and all fuel connections, vents, returns and fills shall be installed and tested prior to shipment. Field or dealer installed tank installations are not acceptable. Tank shall be sized to provide 48 hours of run time, at 100% load.

   The fuel tank shall meet all CMR 527 and Board of Fire Preventions Regulations and be accompanied with approval seal.

   This installation shall include but shall not be limited to the following:
   -Double wall steel fuel tank of the rated capacity
   -Enlarged steel skid base
   -Fuel lines including supply, return and vent lines
   -Fuel fill
   -Fuel level gauge
   -Low fuel warning float switch
   -Rupture basin and alarm
   -Low fuel level alarm relay

   All required appurtenances recommended or required by the manufacturer for a complete and correct installation shall be supplied and the entire assembly shall be factory primed and painted in the manufacturer's standard color to protect against corrosion.
4. Diesel Fuel System
   a. The engine fuel system shall include all equipment normally supplied and recommended by the generator set manufacturer for standby generator service. The fuel engine system equipment shall include (but not be limited to) the following:
      -fuel injection system
      -fuel line solenoid valve

-flexible fuel connections

5. Governor:
   a. The engine shall be equipped with a isochronous governor capable of +/- 0.25% steady-state frequency regulation.
6. Starting System:
   a. The engine shall have a 24 V.D.C. starting system with 24 volt positive engagement solenoid shift starting motor and 35-ampere minimum automatic battery charging alternator with solid state regulation.
   b. Batteries - One set of starting batteries with cables and steel battery rack, shall be included, capable of delivering the manufacturer's recommended minimum cold-cranking amps required at 0°F, per SAE Standard J-537.
   c. Float type battery charger shall be supplied to maintain the starting batteries at full charge. The charger shall be a 10-ampere automatic float and equalize battery charger with +/- 1% constant voltage regulation from no load to full load over +/- 10% AC input line variation, current limited during engine cranking and short circuit conditions, temperature compensated for ambients from -40°C to +60°C, 5% accurate voltmeter and ammeter, fused, reverse polarity and transient protected. Alarm circuit board to meet the requirements of NFPA 110 for low battery voltage, high battery voltage, and battery charger malfunction shall be provided.
   d. There shall be a belt driven battery charging alternator with regulator and charge rate ammeter for charging the batteries while the engine is running or the float type battery charger may be arranged to charge the batteries from the normal source when the engine is shut down and from the generator output when the generator is operating. This shall be accomplished by a relay energized from the generator output.
7. Jacket Water Heater:
   a. An engine jacket water heater shall be provided to maintain the engine jacket at a temperature high enough to assure starting the engine and attaining rated voltage and frequency within ten (10) seconds. The jacket water heater shall be of the capacity recommended by the generator set manufacturer to meet the above conditions. Input to the voltage heater shall be 208 volt, single phase.
8. Safety Shutdown:
   a. The engine shall be equipped with safety contacts for:
      -Low lube oil pressure
      -High jacket water temperature
      -Overspeed
      -Overcrank
9. Engine Instruments:
   a. The following engine instruments shall be connected either in an engine instrument panel or in the generator control panel:
      -Lube oil pressure
      -Water temperature
      -D.C. ammeter
      Any other instruments considered necessary by the manufacturer shall be included.

10. Exhaust System:
    b. A critical grade exhaust silencer suitable for residential type silencing complete with condensate drains shall be supplied of the size recommended by the generator set manufacturer, but in no case less than 4 inches. Silencer shall be as manufactured by Kettell, Maxim or Burgess Manning. An octave band center frequently in Hertz data sheet shall accompany all muffler shop Drawings. A section of seamless, flexible stainless steel exhaust connection of the size and type recommended by the generator set manufacturer, but in no case less than 4-inch diameter and eighteen (18) inches long shall be supplied. If the engine is Vee type, a single exhaust outlet header shall be supplied. The generator stack shall comply with 310 CMR 7.26 (42). Stack height shall be a minimum of 10'-0" above the emergency generator weather housing. For emergency generators rated 1MW and above, the stack shall be 1.5 times the height of the height to the top of the generator enclosure. Manufacturer to verify required height to meet 310 CMR 7.26 (42).
11. Mounting:
    a. The engine and generator shall be close coupled and mounted on a structural steel base designed to maintain proper alignment of the unit.
    b. The unit shall be certified by the manufacturer to be free from any critical torsional vibrations within a range of plus or minus 10% of synchronous speed.
    c. Vibration isolators of the type shall be supplied with the unit. The number of isolators shall be as recommended by the generator set manufacturer.

I. Generator:
1. Rating - 150 KW, 187.5 KVA, 0.8 P.F., 3 phase, 60 cycle, 480/277 volts.
2. Type - Revolving field, 4 pole, single bearing, drip-proof.
3. Exciter - Brushless, direct connected, fully tropicalized, SCR rectifiers, static voltage regulator, rheostat, excellent motor starting capability.
4. Voltage Regulation - Plus or minus 1% of any preset value over the three (3) phase load range. Instantaneous voltage dip or rise, when measured with an oscilloscope, will not exceed 20% upon full load applications or rejection, and will return to preset value within 0.5 seconds.
5. Waveform - Deviation factor of output voltage will not exceed 5% and the value of any individual harmonic will not exceed 2% of the fundamental when operating with an unbalanced load.
6. Temperature Rise - Temperature rise of any component will not exceed the rise permitted by NEMA standards.
7. Rotor - One (1) piece laminations welded and secured to shaft by a key and press fit. Armortisseur windings installed and connected between poles as an aid to parallel operation and improved waveform during unbalanced loads. Field coils machine would on insulated pole body and securely braced. Rotor statically and dynamically balanced.
8. Stator - One (1) piece laminations welded together. Stator coils form wound and placed in insulation slots. Stator pressed and welded in a rigid steel frame.
9. Bearing - Double sealed ball bearing, lubricated for life.
10. Insulation - NEMA Class F insulation.

11. Varnish - Three (3) coats modified polyester type, will not support fungus growth.
12. Cooling - Cast aluminum fan mounted on generator shaft.
13. Radio Suppression - Radiated or conducted radio interference will not affect normal commercial apparatus.
14. Controls:
    b. Unit Mounted - The engine generator set shall include a combination engine generator control panel shock mounted at the generator end of the unit. This unit mounted panel shall include (but not be limited to) the following:
    -Water temperature gauge
    -Oil pressure gauge
    -D.C. battery charge rate ammeter
    -A.C. voltage regulator
    -Voltage adjusting rheostat
    -Start-stop switch
    -A.C. voltmeter
    -A.C. ammeter with current transformers
    -Combination VM-AM phase selector switch
    -Frequency meter
    -Elapsed time meter
    -Automatic start stop control with:
    overcrank protection (manual reset)
    high water temperature
    overspeed
    overcrank
    selector switch - “off,auto,manual”
    -Common failure relay (wire to fire alarm control panel as trouble alarm)
    -Manual reset line circuit breakers as indicated on Drawings furnished with generator, 277/480 volts. Mounted in NEMA 1 enclosures with interrupting capacity of 65,000 amps symmetrical. Circuit breakers which are rated at 1200 amps or more shall have Arc Energy Reduction complying with National Electrical Code 240.87. Fully Rated equipment shall be provided; Series Rated equipment is not acceptable.
    b. The control shall be designed to start the engine upon a closure of a remote contact, arm all safeties, and shutdown the engine when the remote contact is reopened.
    c. The control must be manually reset following any fault condition.
    d. Control power shall be from the engine start battery.

J. Annunciator Panel:
1. A remote mounted engine generator annunciator panel shall be built, tested and supplied by the generator supplier. The annunciator panel shall monitor, visually and audibly, the following:
-Alarm Silence
-Generator Test
-Line Power
-Generator Power
-System Ready
-Alarm Switch off
-Generator Switch off

-Overcrank
-Low Battery Voltage
-High Battery Voltage
-Overspeed
-Emergency Stop
-Low Oil Pressure
-High Water Temperature
-Low Fuel
-Low Water Temperature
-Approach Low Oil Pressure
-Approach High Water Temperature
-Main Tank Rupture

K. Automatic Load Transfer Switches:

1. Automatic transfer switches shall be furnished with full load current rating as indicated on Drawings, 277/480 volts, 3 phase, 4 wire, 4 pole, 60 Hertz, A.C. normal and emergency. Minimum AIC rating shall be 65,000. The transfer switches shall be capable of switching all classes of load, and shall be rated for continuous duty when installed in a non-ventilated enclosure that is constructed in accordance with Underwriters' Laboratories, Inc., standard UL-1008.
2. The transfer switches shall be double throw, actuated by a single electrical operator momentarily energized; and connected to the transfer mechanism by a simple overcenter type linkage with a total transfer time not-to-exceed one-half (1/2) second. The transfer switches shall be capable of transferring successfully in either direction with 70% of rated voltage applied to the switch terminals.
3. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically locked in position without the use of hooks, latches, magnets, or springs; and shall be silver-tungsten alloy protected by arcing contacts, with magnetic blowouts on each pole.
4. The transfer switches shall be equipped with a manual operator that is designed to prevent injury to the operating personnel, if the electrical operator should suddenly become energized during manual transfer. The manual operator shall provide the same contact-to-contact transfer speed as the electrical operator to prevent a flash-over from switching the main contacts slowly.
5. The transfer switches shall be equipped with an elevator pre-signal contact.
6. Engine starting contacts shall be provided to start the generating plant, if any phase of the normal source drops below 70% of rated voltage, after an adjustable time delay period of three (3) to thirty (30) seconds, to allow for momentary dips. The transfer switches shall transfer to emergency, as soon as the voltage and frequency have reached 90% of rated voltage. After restoration of normal power on all phase to 90% of rated voltage, an adjustable time delay period of 0-30 minutes shall delay re-transfer to normal power, until it has had time to stabilize. If the emergency power source should fail during the time period, the time delay shall be by-passed, and the switches shall return immediately to the normal source. After the switches have retransferred to normal, the engine generator shall be allowed to operate at no load for an adjustable period of time (0-5 minutes) to allow it to cool before shutdown. The

transfer switches shall include a test switch to simulate normal power failure pilot lights on the cabinet door to indicate the switch closed on normal or emergency and four (4) auxiliary contacts on the main shaft; two (2) closed on normal, the other two (2) closed on emergency. Included engine exerciser with 0-168 hours timer.

7. Load transfer switches shall be as manufactured by Russelectric, ASCO, Westinghouse, or equal.
8. Provide two hour rated stop/start circuit from generator to all automatic transfer switches.

L. Test:

1. The supplier of the equipment shall provide at no additional charge, any information or supervision required for the proper installation of the equipment. Upon completion of the installation of this unit, a test run of four hours shall be conducted by the equipment manufacturer's factory trained serviceman in the presence of the City Electrical Inspector. Using load banks to test full generator KW, at this time adjustments shall be made for correct operation of the equipment and the following readings taken at 15-minute intervals.
   -Engine jacket water temperature
   -Generator temperature
   -Oil pressure
   -Battery charge rate
   -A.C. volts
   -A.C. amps (all legs)
   -Engine air exhaust temperature
   -Engine oil temperature
2. The unit test shall also be made by utilizing available connected load. The supplier of this equipment shall also furnish and install lube oil in the engine and also drain and refill the engine with new lube oil after the engine-generator test has been completed. If the engine-generator unit should fail this initial test run, as determined by the representative of the Owner, after proper corrective measures have been implemented, replace engine lube oil again after the second test. If any additional tests are required to prove the performance of the engine-generator unit, lube oil shall be replaced after each test run.
3. Prior to shipment of generator to the job site, conduct a 3-hour full load shop test utilizing inductive load to attain full rated load. A written report of this test shall be forwarded to the Engineer for approval prior to shipment. All expense for these tests shall be carried by the Electrical Subcontractor.
4. A power outage test will be conducted by the Electrical Subcontractor, witnessed by the Commissioning Agent, using the Building load when all systems are completed. Electrical Subcontractor shall demonstrate proper operation of the emergency system to supply power to all emergency equipment during the simulated power outage and return back to normal utility service.
5. The Electrical Subcontractor shall pay for all fuel required for testing and shall leave the fuel tank full of fuel and the radiator full of antifreeze at the completion of testing and acceptance of the emergency generator.

M. Weather Housing

1. Weather housing shall be constructed of a minimum 16 gauge steel material. Fixed louvers shall be installed front and back to prevent blowing snow or rain from entering the housing. Roof shall have a crease down the length to prevent water from standing. Roof shall be braced, if necessary, to support the weight of silencer. Side panels and rear panels shall be lockable and removable for access to junction box. Locks must be heavy duty. Housing shall be free of any manufacturer's stickers and logos.
2. The enclosure shall be fabricated and mounted by the generator set manufacturer so as to insure compatibility of all systems. Seller-installed enclosures and enclosures provided by other than the manufacturer of the generator will not be acceptable. The complete assembly shall be factory finished and painted inside and out in the standard color of the manufacturer to help prevent against weathering and corrosion and to maintain an aesthetically pleasing appearance.
3. The enclosure shall be completed lined with a sound installation barrier. This barrier must be not less than 1" thick and have a minimum density of 2 lbs./3 cu. ft. In addition, material must meet UL-94 classification HF-1. This material is intended to absorb airborne noise within the enclosure.
4. The enclosure shall be sized such that all accessories specified herein including but not limited to:
   -Engine/Generator
   -Jacket heaters
   -Batteries
   -Battery charger
   -Base fuel tank
   -Exhaust
   -Line circuit breakers shall be housed within the enclosure.

2.20 TIME CLOCKS

A. Furnish and install time clocks where shown on the Drawings for the control of lighting.

B. Time clocks shall be shall be Tork DLC400BP, Intermatic, Paragon, or equal.

1. Provide a 4 zone lighting controller with photosensor input (Tork model EPC2 photosensor to be supplied with controller).
2. Memory Module shall be capable of being programmed at any one location and inserted into DLC400BP (with memory module socket) in any other remote location.
3. Optional programmer shall be available (Model MMP), capable of accomplishing Windows based settings on a PC for easy duplication of Memory Modules or individualized programs for multiple locations.
4. Each zone shall be capable of independent, user settable turn On and Off light level set points ranging from 1 to 100 footcandles.
5. Three position slide switches shall be provided for each of the 4 zones allowing for user settings based on
   a. time of day or
   b. combination time of day and light level or
   c. light level.

6. Controller shall provide 30 Amp general purpose isolated contacts (unpowered) for each zone as well as a 500 ma, 24VDC output.
7. Controller shall have 1 digital input per channel for:
   a. remote contact closure which can be used to turn corresponding outputs On/Off outside of the normal control time or
   b. remote timed override which can be accomplished for the corresponding outputs with the use of Tork model SSA200R-24.
8. Enclosure shall provide separate wiring compartments for power connections and auxiliary connections.
9. Controller shall be capable of local override On or Off to the next scheduled event using the keypad for each zone.
10. Each zone shall be capable of astronomic function, adjustable from 10-60 degrees Northern or Southern latitude. Each zone can additionally be offset +/- 1-299 minutes for both sunset and sunrise.
11. Controller shall provide automatic daylight saving time (which can be omitted). Leap year adjustment shall be compensated for automatically.
12. Controller shall have 365 day holiday capability with 24 single dates and 4 seasons of unlimited duration.
13. Controller shall be capable of 99 set points with separate scheduling for each day of the week.
14. Controller shall have back-up capability:
   a. Schedule shall be retained for 40 years without power,
   b. real time shall be retained for 6 months using a field replaceable 9V lithium battery.
15. Unit shall have a NEMA type 3, metal indoor/outdoor enclosure.

2.21 FIRE ALARM SYSTEM

A. Provide a dedicated fire alarm system for the New Waste Water Treatment Facility and a dedicated fire alarm system for the School and other Buildings as indicated on the fire alarm riser diagrams.

B. Furnish and install an addressable fire alarm system as indicated on the Drawings and as herein described. The equipment and installation shall comply with the current applicable provisions of the following standards:
   1. NFPA 70 National Electrical Code.
   2. NFPA 71 Central Station Signaling Systems-Protected Premises Unit.
   3. NFPA 72 National Fire Alarm Code.
   4. State Building Codes.
   5. All requirements of the Local Authority Having Jurisdiction.
   6. Underwriters Laboratories, Inc.
   7. Massachusetts Electrical Code.
   8. NFPA 101 Life Safety Code.
   9. Americans with Disabilities Act.

C. The system and all components shall be listed by Underwriters Laboratories, Inc. for use in Fire Protective Signaling Systems under the following standards as applicable:
   1. UL864 Control Units for Fire Protective Signaling Systems.
   2. UL268 Smoke Detectors for Fire Protective Signaling Systems.
   3. UL 268A Smoke Detectors for Duct Applications.

4. UL 217 Smoke Detectors, Single and Multiple Station.
5. UL 521 Heat Detectors for Fire Protective Signaling Systems.
6. UL 228 Door Closers-Holders for Fire Protective Signaling Systems.
7. UL 464 Audible Signaling Appliances.
8. UL 1638 Visual Signaling Appliances.
9. UL 38 Manually Actuated Signaling Boxes.
10. UL 1481 Power supplies for Fire Protective Signaling Systems.
11. City Fire Alarm Regulations.

D. General Requirements

1. Submittals

a. Submit complete documentation for the Fire Alarm/Life Safety System showing the Model Number, type, rating, size, style, Manufacturer's Names, and Manufacturer's Catalog Data Sheets for all items to ensure compliance with these Specifications.

b. Upon Contract Bid approval, and prior to start of system installation, submit Shop Drawings to and obtain written approval from the Fire Department, prior to ordering fire alarm equipment. General requirements are as follows:

1) Submittal of fire rated sealant for penetrations.

2) A riser diagram of the complete fire alarm system. (Typical riser diagrams are not acceptable).

3) A complete point to point installation diagram. (Typical installation diagrams are not acceptable).

4) A complete list of current drain requirements during normal supervisory, trouble, and alarm condition.

5) Battery standby calculations showing total standby power required to meet the specified system requirements.

6) Supplier’s qualifications indicating years in business, service policies, warranty definitions, and list of similar installations.

7) Contractor qualifications, indicating years in business, prior experience with installations that include the type of equipment that is to be supplied, and installers license number and type of license.

c. All substitute equipment proposed as equal to the equipment specified herein, shall meet or exceed the fire alarm equipment standards. For equipment other than that specified, the contractor shall supply proof that such substitute equipment does in fact equal or exceed the features, functions, performance, and quality of the specified equipment. Submit this information for approval by the engineer at least ten (10) days prior to bid.

2. Equipment Manufacturer’s

a. All references to manufacturer's or supplier's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality. Equivalent equipment (compatible UL Listed) from other manufacturer’s may be substituted for the specified equipment.

3. General Equipment and Material Requirements

a. All equipment and components shall be supplied by a factory authorized Notifier/NESCO affiliate. All equipment and material

shall be new and unused and listed by Underwriter's Laboratories for the specific intended purpose. All control panel components and field peripherals shall be designed for continuous duty without degradation of function or performance. All equipment covered by this Specification or noted on Installation Drawings shall be the best equipment suited for the application and shall be provided by a single manufacturer or be recognized and U.L. listed as compatible by both manufacturer's.

b. Furnish and install a full Microprocessor Based, Fire Alarm System according to the following Specifications and as shown on the Drawings.

c. The system will permit maximum system expansion and owner flexibility with a minimum of additional field wiring. The system shall be wired, connected, tested, and left in first class operating condition.

d. The system shall be totally solid state, microprocessor based, to ensure reliable operation, low maintenance costs, and long life.

e. The equipment and completed installation shall meet the approval of the Fire Department, the Authorities having jurisdiction, and in accordance with applicable Sections of the latest edition of NFPA 72 for Auxiliary Fire Alarm Systems, and National Fire Codes.

f. All fire alarm control panels shall be predominately red in color and have a white label with the words FIRE ALARM CONTROL PANEL on the front of the panel with a minimum four (4) inch letter size. No other functions shall be allowed in the panel (e.g. security system).

g. All fire alarm control panels shall provide 30% excess power supply capacity for future expansion.

h. All equipment shall be listed by Underwriters Laboratories.

i. Approved Equipment Suppliers

1) Equipment and materials shall be as manufactured by Notifier or approved equal as manufactured by Edwards or F.C.I. Equipment designations and model numbers herein specified are those of Notifier. It will be the responsibility of the Engineered System Distributor to ensure proper Specification adherence for system operation, final connection, test, turnover, warranty compliance, and after-market service. The distributor of the equipment specified shall be factory trained and certified.

j. All equipment shall be provided by one manufacturer, Notifier, Edwards, F.C.I., or equal.

E. System Operation

1. The system shall provide means to detect fire conditions within a protected property, transmit the alarm to the Fire Department, alert Building occupants in which the alarm occurred with the use of a new fire alarm system communicator, to supervise each system for conditions which would impair proper system operation and to annunciate such abnormal conditions.

2. Except as permitted by the Fire Marshal, the operation of any alarm-initiating device shall cause the evacuation alarm to sound and be

displayed on all evacuation signaling devices in all areas of the Building.

3. Systems designed to sound/display evacuation signals only in designated areas shall be provided with means to sound/display the evacuation signal on all connected devices. This means shall be provided at the control panel.
4. Audible/Visual devices shall be speaker/strobes listed for fire alarm service except as otherwise permitted.
5. Visual signaling devices shall be approved for the purpose and shall operate only in those areas where the evacuation signaling is required to be sounded and shall have the word "FIRE" permanently inscribed on their surfaces.
6. The system shall be electrically/electronically supervised against component failure of the entire audio path including wiring, switches and electrical contacts and shall detect opens, shorts, grounds or loss of signal, which might impair the function of the system.

F. Main Fire Alarm Control Panel:

1. The FACP shall be a Notifier Model NFS2-640 or equal as manufactured by Edwards, or F.C.I. and shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: addressable detectors, addressable modules, printer, annunciators, and other system controlled devices.
2. Network Control Modules
   a. Network Communications Module (NCM-F) shall provide Fire Alarm Control Panels with a means to connect to NOTI•FIRE•NET.
   b. Main FACP located in school shall be equipped with a NCA-2 Network Control Annunciator.
   c. Nodes shall be interconnected via fiber-optic cable in minimum of 2” conduit.
3. System Capacity and General Operation
   a. The control panel shall provide 318 intelligent addressable devices and be expandable to 636 intelligent addressable devices.
   b. The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit Liquid Crystal Display, individual, color coded system status LEDs, and an alphanumeric keypad for the Field Programming and Control of the Fire Alarm System.
   c. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the Fire Alarm Control Panel.
   d. The FACP shall provide the following features:
      1) Drift Compensation to extend detector accuracy over life.
      2) Sensitivity Test, meeting requirements of NFPA 72.
      3) Maintenance Alerts to warn of excessive compensation.
      4) System Status Reports to display or printer.
      5) Alarm Verification, with verification counters.
      6) PAS pre-signal, meeting NFPA 72 requirements.
      7) Rapid manual station reporting (less than 2 seconds).
      8) Non-Alarm points for general (non-fire) control.

9) Periodic Detector Test, conducted automatically by software.
10) Pre-alarm for advanced fire warning.
11) Counting "cross-zone" options.
12) Temporal coding.
13) Walk Test, with check for two detectors set to same address.
14) Control-By-Time for non-fire operations, with holidays.
15) Day/Night automatic adjustment of detector sensitivity.
16) Device Blink Control for sleeping areas.

e. Central Microprocessor
1) The Microprocessor unit shall communicate with, monitor, and control all external interfaces with the control panel. It shall include EPROM for system program storage; non-volatile memory for Building-specific program storage; and a "watch dog" timer circuit to detect and report microprocessor failure.
2) The Microprocessor unit shall contain and execute all control-by-event programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory, and shall not be lost even if system primary and secondary power failure occurs.
3) The Microprocessor Unit shall also provide a Real-Time Clock for time annotation of system displays, printer, and history file. The Time-of-Day and date shall not be lost if system primary and secondary power supplies fail. The Real Time Clock may also be used to control non-fire functions at programmed time-of-day, day-of-week, and day-of-year.

f. Display
1) The Display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.
2) The Display shall include status information and custom alphanumeric labels for all Intelligent Detectors, Addressable Modules, and Software zones.
3) The Display shall provide an 80-character backlit alphanumeric Liquid Crystal Display (LCD). It shall also provide 8 Light-Emitting-Diodes (LEDs) that will indicate the status of the following system parameters: POWER, FIRE ALARM, PRE-ALARM, SECURITY, SUPERVISORY, SYSTEM TROUBLE, SIGNALS SILENCED and POINT DISABLED
4) The Display shall provide a full QWERTY key touch pad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels shall be provided to prevent unauthorized system control or programming.
5) The Display shall include the following operator functions: SIGNAL SILENCE, RESET, DRILL, ACKNOWLEDGE and LAMP TEST.

G. System Functional Operation

1. System Alarm Detection and Reporting.

a. When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

1) The System Alarm LED shall flash.

2) A local Piezo-Electric signal in the control panel shall sound.

3) The 80-character LCD display shall indicate all information associated with the Fire Alarm condition, including: type of alarm point, its location within the protected premises, and the time and date of that activation.

4) All system output programs assigned via control-by-event equations to be activated by the particular point in alarm shall be executed, and the associated System Outputs (Alarm Indicating Appliances and/or relays) shall be activated.

a) Signals shall be sent to the Fire Department via masterboxes and antennas as indicated on Drawings. Installations shall meet all Fire Alarm system requirements for masterbox connections as provided by the Fire Department.

A signal shall be sent to a central station via telephone dialer. Provide Cat 5E cable to Building telephone terminal board.

b) Close all fire doors.

c) Capture the elevator.

d) Shut down all HVAC units equipped with duct smoke detectors.

5) Unacknowledged alarm messages shall have priority over trouble messages, and if such an Alarm occurs during a Trouble sequence, the Alarm condition will have display priority.

2. System Trouble Detection.

a. When a trouble condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:

1) The System Trouble LED shall flash.

2) A local Piezo electric signal in the control panel shall sound.

3) The 80-character LCD display shall indicate all information associated with the Fire Alarm trouble condition, including: type of trouble point, its location within the protected premises, and the time and date of that activation.

4) If any of the available optional serially connected equipment is being used, then each of the connected peripherals will display/print the information associated with the Fire Alarm Control Panel condition, including the time/date stamping of the change of status event.

5) If applicable, all system output programs assigned via

control-by-event equations to be activated by the particular point in trouble shall be executed, and the associated System Outputs (Trouble Indicating Appliances and/or relays) shall be activated.

b. Unacknowledged alarm messages shall have priority over trouble messages, and if such an Alarm occurs during a Trouble sequence, the Alarm condition will have display priority.

3. System Common Control Switch Operation.

a. Acknowledge (ACK/STEP) Switch.

1) Activation of the control panel Acknowledge switch in response to a single new Alarm and/or Trouble condition shall silence the local panel piezo electric signal and change the System Alarm or Trouble LED from flashing mode to steady-ON mode. If additional new Alarm or Trouble conditions exist or are detected and reported in the system, depression of this switch shall advance the 80-character LCD display to the next Alarm or Trouble condition.

2) In this case, the local piezo sounder shall not silence, and the Alarm/Trouble LEDs shall not transfer to their steady-on mode, thus signaling to the operator that more Alarm/Trouble conditions are present in the system.

3) Alarm conditions shall always have display priority before Trouble conditions. Depression of the Acknowledge switch shall cause a corresponding (time-stamped) message to be displayed on all system peripheral equipment (if used).

4) Occurrence of any new Alarm or Trouble conditions in the system shall cause the Control Panel to resound the Local Piezo sounder and repeat the Alarm or Trouble sequences.

b. Signal Silence Switch.

1) Activation of the Signal Silence Switch shall cause all programmed Alarm Indicating Appliances and relays to return to the normal condition after an alarm condition. The selection of indicating circuits and relays, which are silenceable by this switch, shall be fully field programmable within the confines of all applicable standards.

c. System Reset Switch.

1) Activation of the System Reset Switch shall cause all electronically latched initiating devices, appliances or software zones, as well as all associated output devices and circuits, to return to their normal condition.

2) If the alarm condition(s) still exist, or if they re-occur in the system after System Reset Switch activation, the system shall then resound the alarm conditions.

d. Alarm Verification

1) The FACP shall provide Alarm Verification per point with tally. Each of the Intelligent/Addressable Smoke Detectors in the system may be independently selected and enabled to be an alarm verified detector. The Alarm Verification Function shall be from 0-60 seconds and

each detector shall be able to be enabled/disabled during the field programming of the system, or any time after system turn-on. The Alarm Verification shall not require any additional hardware to be added to the Fire Alarm Control Panel.

e. System Reports.

1) The system will be able to generate and print a summary of all of the Detectors, Modules, Pull Stations, and Zones, which are currently active in the System. This printout will require password protection to prevent unauthorized user access, and will automatically print the system report using "soft" (single push) keys. No computer expertise will be required to initiate the System Report sequence. Provide one (1) printer.

f. Signal Silence Inhibit Time

1) The Fire Alarm System shall be equipped with a Signal Silence Inhibit feature, which will prevent the operator from silencing any of the signals for a period of seconds. (0-300 seconds). The function of this Signal Silence Inhibit Timer shall be field programmable and its limit shall be field definable, without the need for the installation of any hardware modules into the system.

g. Automatic Signal Cutout Time

1) The Fire Alarm System shall be equipped with a Automatic Signal Silence Cut-Out feature which will automatically silence all of the signals after a period of seconds. (000 none; 600 to 900 seconds). The function of this Automatic Signal Silence Cut-Out Timer shall be field programmable and its limit shall be field definable, without the need for the installation of any hardware modules into the system.

h. System Point Operations

1) Device Disable

a) Any Device in the system may be Enabled or Disabled through the system keypad without the need to reprogram or deprogram any of the operational parameters of the point such as Control-By-Event linkages

2) Output Point Control

a) Any system output point may be turned on or off from the system keypad.

3) Point Read

a) The system shall be able to perform a point status diagnostic function without the need for peripheral equipment to make the readings. Each point will provide the following parameters:

(1) Device Status
(2) Device Type
(3) Custom Device Label (32 character extended)
(4) Zone CBE Selection
(5) Current Alarm Reading (percent)
(6) Alarm Sensitivity Level

(7) Pre-Alarm Sensitivity Level
(8) Cooperative Multi-Detector selection
(9) Alarm Verification
(10) Device SLC Address
(11) Switch Inhibit (on/off)
(12) Silenceable/Non-silenceable
(13) Walk Test

4) Point Status Report
   a) Upon command from a password-authorized operator of the system, a report will be generated which details each and every installed detector, module, zone, and annunciator, as well as any and all field programmed parameters which have been assigned to these points and (optionally) printed.
5) System History Recording and Reporting
   a) The Fire Alarm Control Panel shall contain a History Buffer, which will be capable of storing up to 800 system output/input/control activations plus a separate 200 event alarm-only file. Each of these activations will be stored and time and date stamped with the actual time of the activation, until a password authorized operator requests that the contents be either displayed, or printed. The contents of the History Buffer may be manually reviewed; one event at a time, and the actual number of activations may also be displayed and or printed. History Buffer Reports (whether Displayed or Printed), will be instantly distinguishable from all other displayed or printed system reports through the use of a semicolon in the time/date stamp of the data.
6) Automatic Detector Maintenance Alert
   a) The Fire Alarm Control Panel shall automatically interrogate each Intelligent System Detector and shall analyze the detector responses over a period of time. The FACP shall provide three levels of Maintenance Alert.
      (1) Low Chamber Value. This warning shall indicate that there is a hardware problem in the detector.
      (2) Maintenance Alert. This warning shall indicate that the dust accumulation is near but below the allowed level and that the detector needs maintenance before the detector performance is compromised.
      (3) Maintenance Urgent. This warning shall indicate that the dust accumulation is above the allowed limit.
7) Voice Control Module.
   a) The voice control (speaker-circuit) module shall provide four fully supervised Class A Style Z

NAC speaker circuits. An expansion circuit board will allow for expansion up to eight circuits per module.

b) Each speaker circuit shall be capable of switching up to 30 watts maximum per circuitor 60 watts per four circuit module.

c) The module shall provide green ON/OFF LEDs and yellow trouble LEDs.

d) Each speaker circuit module shall be provided with removable wiring terminal blocks for ease of installation and service. The terminal strips shall be UL listed for use with up to 12 AWG wire.

8) Voice Control Center.

a) Shall provide hand held microphone with priority push to talk switch.

b) Shall provide all call switch and indicator to quickly activate all speaker circuits.

c) Shall provide custom digital message, tone generator and amplifiers.

H. Monitor Module

1. Monitor Modules, Model No. FMM-1, shall be provided to connect one supervised IDC zone of conventional Alarm Initiating Devices (any N.O. dry contact device, including 4-wire smoke detectors, manual pull stations, waterflow devices and supervisory devices), to one of the Fire Alarm Control Panel Signaling Line Circuit (SLC) Loops. The Monitor Module shall mount in a 4-inch square, 2-1/8" deep electrical box, to a surface mounted back box, or directly into the Fire Alarm Control Panel.
2. The IDC zone may be wired for Style D or Style B operation. The Monitor module shall provide address-setting means using rotary decimal switches and shall also store an internal identifying code, which the Fire Alarm Control Panel shall use to identify the type of device. An LED shall be provided which shall flash under normal conditions, indicating that the Monitor module is operational and in regular communication with the control panel.

I. Control Module

1. Control Modules, Model Number FCM-1, shall be provided to supervise and control the operation of one conventional Indicating Appliance Circuit (IAC) of compatible, 24 VDC powered, polarized Audio/Visual Indicating Appliances. The Control Module shall mount in a standard 4-inch square, 2-1/8" deep electrical box, or to a surface mounted backbox, or directly in the Fire Alarm Control Panel.
2. The IAC may be wired for Style Z or Style Y IAC (Up to 48 Watts of Audio Speaker or 1 Amp of Inductive A/V Signal, or 2 Amps of Resistive A/V Signal) operation.
3. Audio/Visual Power shall be provided by a separate supervised Power Loop from the main Fire Alarm Control Panel or from a supervised, U.L. Listed Remote Power Supply or Amplifier.
4. The Control Module shall provide address-setting means using rotary decimal switches and shall also store an internal identifying code, which the Control Panel shall use to identify the type of device. An LED shall be provided which shall flash under normal conditions, indicating that the

Control Module is operational and is in regular communication with the Control Panel.

J. Relay Module

1. The addressable relay module, FRM-1, shall provide the system with a dry-contact output for activating a variety of auxiliary devices, such as fans, dampers, and control equipment. Addressability allows the dry contact to be activated, either manually or through panel programming. The Relay Module shall mount in a standard 4-inch square, 2-1/8" deep electrical box, or to a surface mounted backbox, or directly in the Fire Alarm Control Panel.

K. Isolator Module

1. Isolator Modules, Model Number ISO-X, shall be provided to automatically isolate wire-to-wire short circuits on an SLC loop. The Isolator Module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC Loop. If a wire-to-wire short occurs, the Isolator Module shall automatically open-circuit (disconnect) the SLC loop. When the short circuit condition is corrected, the Isolator Module shall automatically re-connect the isolated section of the SLC loop. The Isolator Module shall not require any address setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an Isolator Module after its normal operation. The Isolator Module shall mount in a standard 4-inch deep electrical box, in a surface mounted backbox, or in the Fire Alarm Control Panel. It shall provide a single LED, which shall flash, to indicate that the Isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

L. Addressable Manual Stations

1. Addressable Manual Stations, Model Number NBG-12LX, shall be provided to connect one addressable, supervised Manual Station to one of the Fire Alarm Control Panel Signaling Line Circuit (SLC) Loops.
2. The Manual Station shall, on command from the Control Panel, send data to the panel representing the state of the manual switch. Manual Fire Alarm Stations shall be non-crush tube type with a key operated test-reset lock, and shall be designed so that after actual Emergency Operation, they cannot be restored to normal use except by the use of a key. All operated stations shall have a positive, visual indication of operation and shall clearly show the word “ACTIVATED” upon activation. Manual Stations shall be constructed of LEXAN with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches or larger. Stations shall be suitable for surface mounting on matching backbox, or semi-flush mounting on a standard single gang box, and shall be installed within the limits defined by the American with Disabilities Act (ADA). The Manual Station shall provide address-setting means using rotary decimal switches and shall also store an internal identifying code, which the control panel shall use to identify the type of device. An LED shall be provided which shall flash under normal conditions, indicating that the Manual Station is operational and in regular communication with the control panel. The LED may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. The station shall

provide a key reset. The key shall be the same as used for the fire control panel.

3. Color of devices shall be red.

M. Intelligent and Addressable Photoelectric Smoke Detectors

1. The Intelligent Photoelectric Detectors, Model Number FSP-851, shall be Intelligent and Addressable, and shall connect with two wires to one of the Fire Alarm Control Panel Signaling Line Circuit Loops. The detectors shall use the photoelectric principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
2. The detectors shall be ceiling-mount and shall include a twist-lock base. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself, by activating a magnetic switch, or may be activated remotely on command from the control panel. The detectors shall provide address-setting means on the detector head using rotary decimal switches. Because of the possibility of installation error, systems that use binary jumpers or dipswitches to set the address are not acceptable. The detectors shall also store an internal identifying code, which the control panel shall use to identify the type of detector.
3. The detectors shall provide dual alarm and power LEDs providing 360 degree viewing angle. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel. Both LEDs may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the flashing mode operation of the detector LEDs shall be controlled through the system field program. An output connection shall also be provided in the base to connect an external remote alarm LED. Detectors that do not provide a 360-degree viewing angle will not acceptable.
4. The detector sensitivity shall be set through the Fire Alarm Control Panel, and shall be adjustable in the field through the field programming of the system. There shall be 9 levels of alarm sensitivity and 9 levels of pre-alarm sensitivity to choose from.
5. The detector shall also have the ability to be set for Self-Optimizing that will allow the detector to set itself to the best suited sensitivity.
6. The detector shall display its address, at the detector, during Walk Test.

N. Intelligent Addressable Duct Smoke Detector

1. The Intelligent Addressable Photoelectric Duct Detectors, DNR with FSP-851R shall be Intelligent and Addressable devices, and shall be connected with two wires to one of the Fire Alarm Control Panel Signaling Line Circuits.
2. When sufficient smoke is sensed, an alarm signal is initiated at the fire alarm control panel and appropriate action is taken to shut off fans and blowers and change over air handling systems, throughout the areas served by the duct system.
3. Remote Test Station, RTS1515KEY, shall be provided as shown on the plans and shall be labeled with device number, information corresponding to Roof Top Unit designations. Where Roof Top Units with duct smoke detectors are above suspended ceilings, the tile grid shall be

marked with a red dot if an LED is not present.

4. The Electrical Subcontractor shall wire from the duct smoke detector to its respective unit motor starter to shut the unit down upon detection of smoke. The duct smoke detector shall activate the Building's alarm notification appliances.

O. Intelligent Heat Detectors

1. The Intelligent Heat Detectors, Model Number FST-851, shall be Intelligent and Addressable devices, and shall connect with two wires to one of the Fire Alarm Control Panel Signaling Line circuits.
2. The detectors shall use an electronic sensor to measure thermal condition caused by a fire and shall, on command from the control panel, send data to the panel representing the analog level of such thermal measurements. The heat detector shall provide a Fixed 135 degree or a 135-degree Rate of Rise detection as indicated on the Drawings.
3. The detectors shall be ceiling-mount and shall include a twist-lock base.
4. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
5. The detectors shall provide address-setting means on the detector head using a decimal switch. Because of the possibility of installation error, systems that use binary jumpers or dipswitches to set the address are not acceptable.
6. The detectors shall provide dual alarm and power LEDs providing 360 degree viewing angle. Both LEDs shall flash under normal conditions. In certain applications, LEDs may be selected to be polled without flashing through system programming. Both LEDs may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. Detectors that do not provide a 360-degree viewing angle will not be acceptable.
7. An output connection shall also be provided in the base to connect an external remote alarm LED.
8. The heat detector shall display its address, at the detector, during Walk Test.

P. Carbon Monoxide Detectors

1. Furnish and install, where shown on the plans, carbon monoxide detectors, Ultraguard Model CODET 12-24 or equal. Carbon monoxide detectors shall operate on 24 volts and shall be wired through a separate monitor module as a zone and power supply. Altronix Model AL300ULXR or equal.
2. Carbon monoxide detectors shall be wired as a supervisory signal. Provide all necessary relays and wiring.

Q. ADA High Intensity Strobe Audio-Visual Alarm Indicating Appliances

1. Notifier Model SPSR speaker strobe with multi candela capability shall be listed with Underwriter's Laboratories for use with Fire Protective Signaling Systems. Speaker strobe shall have a minimum sound output of 96dB @ 10 feet and shall be flush mounted. The speaker shall sound in a Temporal pattern. The strobe shall have a candela rating that meets or exceeds the requirements of the Americans with Disabilities Act (ADA)

and shall be of such rating as shown on the Drawings. The device shall be rated at 24 VDC nominally and have an acceptable operating range of 20-30 VDC.

2. The device shall mount to a 4" square deep with extension ring.
3. All strobes shall be synchronized.
4. Color of devices shall be white, unless otherwise noted.

R. ADA High Intensity Strobe High Audio Output/Audio-Visual Alarm Indicating Appliances

1. Wheelock high performance speakers (ET70-W) and series speaker strobes (ET70-24MCW-FW) shall provide high audio output, clear audibility and field selectable taps from 1/8 to 8 watts.
2. Any additional amplifiers shall be provided to accommodate required wattage.
3. The device shall mount to a 4” square deep box with extension ring.
4. All strobes shall be synchronized.
5. Color of devices shall be white, unless otherwise noted.

S. ADA High Intensity Strobe Only Unit

1. Notifier Model SR as shown on Drawings, shall be listed with Underwriter's Laboratories for use with Fire Protective Signaling Systems and accepted by the local Authority Having Jurisdiction. The strobe shall meet or exceed the requirements of the Americans with Disabilities Act (ADA) and shall be of such rating as shown on the Drawings. The device shall be rated at 24 vdc and shall have a flash rate of 1 HZ.
2. All strobes shall be synchronized.
3. Color of devices shall be white, unless otherwise noted.

T. Exterior Strobe Light

1. Maxi-Signal 490S series. The exterior strobe shall also be of weather-resistant rain tight construction.
2. Provide weatherproof backbox.
3. Weatherproof strobe shall be installed where directed by the Fire Department.
4. Color of devices shall be red.

U. Magnetic Door Holders

1. Furnish and install, where shown on the plans, magnetic door holders, Notifier Model FM series. Magnetic door holders shall operate from 120VAC.
2. The housing and contact plates shall be brushed zinc finish. Units shall have a holding force of approximately 35 pounds.

V. Stopper Covers

1. Provide Notifier Model STI1100 stopper covers on all manual pull stations. The protective shield shall be tamper proof, clear lexan with red frame installed over the fire alarm pull station. When the protective shield is lifted to gain access to the manual pull station, the protective shield shall sound a loud, piercing warning horn. The horn shall be battery powered and may be silenced by lowering and re-aligning the protective shield. Each stopper cover shall include a battery and the Electrical Subcontractor shall furnish two dozen spare batteries for replacement parts.

W. LCD Alphanumeric Display Annunciators:

1. The Alphanumeric Display annunciators shall be a supervised, local or remotely located back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English test.
2. The LCD annunciators shall display all alarm and trouble conditions in the system.
3. The annunciators shall connect to an EIA 485 interface,
4. Up to 32 LCD annunciators may be connected to the interface, each with Acknowledge, Silence and Reset controls for the FAC.
5. Provide a graphic annunciator adjacent to each LCD annunciator. The graphic annunciator shall conform to Fire Department requirements.

X. Fire Alarm/Life Safety System Installation

1. Provide and install the system in accordance with the Drawings and Specifications, all applicable Codes, and manufacturer's' recommendations. All wiring shall be installed in strict compliance with all the provisions of National Electrical Code, Power Limited Fire Protective Signaling Circuits or if required may be reclassified as non-power limited and wired in accordance with National Electrical Code. Upon completion, the contractor shall so certify in writing to the owner and Contractor.
2. Removal of a smoke detector will not interfere with the transmission of signal from manual stations, waterflow switches, and other initiating devices.
3. All Equipment shall be attached to a non load-bearing wall, and shall be held firmly in place. Fastening and supports shall be adequate to support the required load, and provide a safety factor of five.
4. As indicated on the Riser/Connection diagram Drawings, each system alarm point or zone in the system shall be uniquely labeled within the Fire Alarm Control Panel. Names of the system point(s)/zone(s) shall be as defined by the Engineer.
5. Fire Sprinkler Activation detecting System(s) shall each be indicated on a separate zone in the Fire Alarm Control Panel.
6. Fire Alarm Control Panel will be mounted with the center of panel 60 inches above floor level.
7. All junction boxes shall be sprayed red and labeled "Fire Alarm". Wiring color codes shall be maintained throughout the installation.
8. Cable and Wiring.
   a. Conduit and Conductors: Provide complete wiring and conduit between all equipment. Unless otherwise specified within the Installation Manual of the specific equipment being used, all field wiring shall be minimum #14 Type in separate conduit, maximum 40% full, and shall be approved for use as Fire Alarm Cable. Conduits of proper size shall be installed from the Control Panel; Equipment to field devices. All field devices shall be mounted upon U.L. Listed Electrical junction boxes. All splices in field wiring shall be made in U.L. Listed Electrical junction boxes. All Electrical junction boxes shall be labeled as "Fire Alarm System" with decal or other approved markings. The Fire Alarm/Life Safety Installation shall comply fully with all Local, State and National Codes, and the Local Authority Having Jurisdiction (AHJ).
   b. The Fire Alarm Control Panel shall be connected to a separate

dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the Main Power Distribution Panel as FIRE ALARM. Fire Alarm Control Panel Primary Power wiring shall be 12 AWG. The Control Panel Cabinet shall be grounded securely to either a cold water pipe or grounding rod. Conduit shall enter into the Fire Alarm Control Panel backbox only at those areas of the backbox, which have factory conduit knockouts.

c. All field wiring shall be completely supervised. In the event of a primary power failure, disconnected standby battery, removal of any internal modules, or any open circuits in the field wiring; an audible and visual trouble signal will be activated until the system and its associated field wiring are restored to normal condition.

d. Plenum rated fire alarm MC cable shall be allowed above ceilings, in attics, and in other areas allowing surface wiring if so approved by the Local Authority Having Jurisdiction. Where fire alarm MC cable would be subject to damage, it shall be protected in EMT conduit.

e. Cable shall be the type listed for Fire Alarm/Life Safety use and shall be installed per National Electrical Code.

f. Cable for Addressable/Intelligent Alarm Initiating Appliances (Manual Stations, Heat Detectors, and Smoke Detectors) shall be connected as shown on the riser diagram. Cable shall be installed from the Fire Alarm Control Panel to all devices in that Signaling Line Circuit (SLC) loop. The connection and continuity of the wires, which make up that SLC loop will be continuously supervised for shorts, opens, and ground circuit conditions.

g. Cable for Alarm Initiating Devices and Appliances (Manual Stations, Heat Detectors, and Smoke Detectors) shall be connected to the Fire Alarm Control Panel, and labeled as shown on the riser diagram. Cable shall be installed from the Fire Alarm Control Panel to all devices in that Initiating Device Circuit (IDC) loop. The connection of the cable to that loop will be continuously supervised for shorts, opens, and ground circuit conditions.

h. Cable for Alarm Indicating Appliances (Audible or Visual or combination signal(s)) shall be connected on a per zone basis. Cable shall be installed from the Fire Alarm Control Panel to all devices in that Indicating Appliance Circuit (IAC) loop. The connection of the cable to that loop will be continuously supervised for shorts, opens, and ground circuit conditions.

i. Cable must be separated from any open conductors of Power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, as per National Electrical Code.

j. All exposed cable below 84 inches from the surface of the finished floor, or other locations where the cable may become exposed and/or damaged, must be within a steel conduit.

k. Conduits must also be provided in elevator shafts and hoist ways. Cables within ducts or plenums must conform with the Specifications of the National Electrical Code.

l. Conduit shall not enter the Fire Alarm Control Panel, or any other remotely mounted Control Panel equipment or back boxes, except where conduit entry knockouts have been provided by the

factory.

m. Cable shall meet all the manufacturer's requirements including shielding, twists, capacitance, resistance and gauge. The cable shall not be installed without approval of the manufacturer in writing.

Y. Final System Acceptance.

1. The system will be accepted only after a Factory-Trained Distributor in the presence of the Electrical Subcontractor, the owner's representative and the Local Fire Marshal have accomplished a satisfactory test of the entire system, in accordance with NFPA 72. Upon completion of a successful test, the Electrical Subcontractor shall so certify in writing to the Owner. The Electrical Subcontractor shall pay all back charges assessed by the Fire Department for all fire alarm system tests.
2. The Electrical Subcontractor shall submit, in the Shop Drawings, a letter confirming that they will provide a U.L. listed testing company to provide the acceptance test.
3. The Electrical Subcontractor will present a complete set of "As- Built" Fire Alarm/Life Safety system Drawings, and the factory supplied Operator's Manual to the Building Owner's Representative and the local AHJ.
4. The Electrical Subcontractor shall provide the on-site services of an Authorized, Factory Trained technical representative to supervise all connections and fully test all devices and components of the system during installation phase.
5. The Electrical Subcontractor shall provide comprehensive Training on the operation, proper use, and testing of the installed Fire Alarm System to the Building Owner's Representative, and the local AHJ

Z. Warranty

1. The Electrical Subcontractor shall warrant the completed fire alarm system, wiring and equipment, to be free from inherent mechanical and electrical defects for a period of two (2) years from the date of the completed and certified test or from the date of the first beneficial use.

2.22 PUBLIC SAFETY SIGNAL BOOSTER SYSTEM

A. Furnish and install a signal booster system complete with all components and wiring required for compliance with all applicable Codes and Regulations. The system shall include but not be limited to the following:

1. One donor antenna to be located on the roof. Run a ½" plenum rated non-radiating coaxial cable from the directional antenna to the Bidirectional Amplifier (BDA). Cable shall be equal to ICA12-50JPLW (1/2" plenum coax).
2. This Specification is based upon an NFPA Compliant TX/RX Rescue Line SBII system. The BDA shall be a TX/RX Rescue Line SBII, Motorola, and Bird Technologies, or equal. Frequencies shall be coordinated with the Fire and Police departments and the amplifier shall meet all Fire and Police department communications requirements.
3. Furnish a ½" plenum rated radiating cable from the BDA to at minimum above the corridor ceilings on each floor. Radiating cable shall be supported every 5'-0" from the structure. Provide

antennas at a minimum of one every 200' along the radiating cable routing. Provide any additional cabling in strict accordance with manufacturer's Specifications as well as current National Electrical Code to provide complete coverage for the system. A pre and a post signal strength test shall be provided at the job site. Signal strengths shall be noted on a set of plans both pre and post test.

B. Vertical riser backbone cabling and associated splitters, couplers, and taps shall be installed in two hour rated electric rooms and shafts. Splitters, couplers, and taps throughout system shall be accessible for testing, future service, and/or replacement. Provide access panels where required. Where vertical riser backbone cabling exits two hour rated enclosure provide fire stopping around penetrations.

C. Signal Strength

1. The Fire and Police Department radio test shall check the signal reception in several locations on the floor area. Signal strength shall provide for clear reception throughout the Building utilizing the type of hand held radio unit that is used by the Fire and Police Department. Quantity of test locations shall be determined and conducted by the local department representative. Each floor of the Building shall be divided into a grid of approximately twenty (20) equal areas. A maximum of one (1) area will be allowed to fail the test per floor. A spot located approximately in the center of a grid area will be selected for the test. Once the spot has been selected, prospecting for a better spot within the grid area will not be permitted. Field strength testing instruments are to be recently calibrated (1 year) and of the frequency selective type incorporating a flexible antenna similar to the ones used on the hand held transceivers.

D. Required Signal Levels:

1. Signal strength shall provide for clear reception throughout the Building utilizing hand held radio units of the type(s), which are used by the Fire/Police Department. Signal strength testing shall follow TSB-88 standards using delivered audio quality measurements (DAQ).
2. A minimum signal strength of –95 dBm (DAQ4) shall be available on over 99% of the floor area required to be covered when transmitted from the fire department.
3. A minimum signal strength of –95 dBm (DAQ4) shall be received at the fire department system from over 99% of the floor area required to be covered.

E. Primary Power

1. The emergency responder radio coverage system shall be powered by a dedicated independent circuit of sufficient size. The circuit shall be clearly marked. The location of the electrical panel shall be clearly marked at location approved by the fire official. The primary power source shall be supplied from a dedicated twenty (20) ampere branch circuit and comply with NFPA 72, National Fire Alarm Code, 2010 edition.

F. Secondary Power

1. The emergency responder radio coverage system shall be equipped with a secondary source of power. The secondary source of power shall be a backup battery system which is serially connected to the BDA system (no UPS units). The secondary power supply shall supply power automatically when the primary power source is lost. The secondary source of power shall be capable of operating the emergency responder radio coverage system for a period of at least 12 hours at 100% system operation capacity. All components of the battery backup system shall be housed completely in a NEMA 4 or 4X cabinet and mount below the BDA. System shall have front panel display and alarms. Monitoring the integrity of power supplies shall be in accordance with NFPA 72, National Fire Alarm Code 2010 Edition. Unit shall be TX/RX 6160 Battery Option.

G. Alarm Monitoring Panel

1. A dedicated monitoring panel shall be provided adjacent to the fire alarm control panel to annunciate the status of the signal booster. The monitoring panel shall provide visual and labeled indication of the following for the booster:
   a. Normal AC power
   b. Signal booster trouble
   c. Loss of normal AC power
   d. Failure of battery charger
   e. Low battery capacity
2. The above mentioned alarm points shall be outputs from the BDA system as dedicated relay points. These can be monitored via addressable monitor modules to the fire alarm system in lieu of a dedicated BDA monitoring panel.

H. All equipment shall have a current FCC Certification.

I. Equipment integrator shall be a certified service center with factory certified technician(s).

J. Warranty: The BDA shall include a 5 year equipment warranty. Include any necessary costs for equipment to contain this warranty level.

K. Submittals:

1. Submit manufacturer's data on system and components including Shop Drawings, floor plans with layout of all equipment, cabling, riser diagram for project (typical riser diagram is not acceptable), and mounting equipment and details.
2. Provide copies of personnel certifications in submittal.

2.23 TELEPHONE/DATA/VIDEO OUTLET AND CONDUIT SYSTEM

A. Furnish and install back boxes and conduits as called for on the Drawings.

B. Refer to Drawings for back box requirements and locations.

C. Where back boxes are located in environmental air plenum ceiling areas, the conduits shall be run to the nearest corridor located outside the environmental air plenum area.

D. Actual back box locations and equipment shall be confirmed in the field with Architect and Owner before installation.

E. Provide blank cover plate for each back box location.

2.24 ELECTRONIC SAFETY AND SECURITY

A. The Electrical Subcontractor shall be responsible for properly preparing the project for installation by the Electronic Safety and Security Integrator, Section 28 13 00, 28 16 00 and 28 23 00 as specified.

B. Responsibilities of the Electrical Subcontractor shall include: The Electrical Subcontractor shall be responsible for providing and installing all related Building preparation including, but not limited to: outlet boxes, pathways, power, cableways, and J hooks to facilitate a neat and orderly installation of cables, cable protection, surface raceways, cable supports, conduits with bushings, conduit stubs with bushings. Sleeves with bushings (all conduits, stubs, and sleeves shall be brought to an accessible hallway ceiling or accessible area below floor), backboxes, pull strings, bonding, grounding, core drilling, cutting, patching, fireproofing of penetrations and openings, environmental seals, smoke and fire stopping seals including all conduits, raceways, sleeves, and slots where cables pass from one location to another, removal and re-installation of ceiling to install concealed cabling, seismic supports, supplementary steel and channels, for a completely operational system as specified. The Electrical Subcontractor shall also accept delivery and properly store and secure all equipment and materials required by the Systems Integrator. The Electrical Subcontractor shall install all specialized backboxes.

C. Responsibilities of the Electronic Safety and Security Integrator for this Section: The Electronic Safety and Security Integrator shall be responsible for providing, installing, programming, troubleshooting, training and warranty service of all cabling and equipment specified in this Section for a completely operational system. The Electronic Safety and Security Integrator shall furnish all specialized backboxes to the Electrical Subcontractor for their installation.

2.25 CABLE TRAY

A. Conform to NEMA VE1.

B. Ladder Type Cable Trays:
1. Material: Aluminum 6036-T6 alloy.
2. Width: 20 inches overall.
3. Inside depth: 6 inches.
4. Cross rung spacing: 9 inches.
5. Minimum fitting radius: 24 inches.
6. Design Load: Provide tray capable of supporting 50 pounds per linear foot, when supported on 12 foot centers.
7. Hangers: 1/2 inch diameter threaded steel rods; furnish with pair of 1/2 inch nut and washers for each rod. Rods shall be supported from the structural floor above, independent of furred or suspended ceilings, unless otherwise noted.

C. Cable Tray Accessories
1. Fittings: Furnish tees, crosses, risers, elbows, and other fittings as indicated, manufactured with the same materials and finishes as the cable trays.
2. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

D. Cable Tray and accessories color shall be black.

2.26 SCOREBOARDS

A. Furnish as hereinafter specified wall mounted Fair-Play electronic scoreboards as indicated on Drawings. Each scoreboard shall include all equipment as hereinafter specified and shall be a Model BB-1620-4 LED Digit with metric clock. Equipment in this Section shall be as manufactured by Fair-Play, Daktronics, Nevco, or equal.
1. Scoreboard Construction
a. BB-1620-4 LED Digit scoreboard
Provide BB-1620-4 scoreboards as indicated on Drawings, 9' 0" x 5' 0" displaying:
◊ Automatic second-by-second display of time remaining or time elapsed in minutes and seconds for periods up to 99:59 minutes or less. Metric clock shows tenths of a second and seconds during last minute, also two hour memory in case of power loss.
◊ Period number 0 through 9
◊ Bonus arrows
◊ Team scores 0 through 199
◊ Team fouls 0 through 99
◊ Uniform number 0 through 99
◊ Total fouls for individual player 0 through 9
◊ Volleyball and wrestling captions
◊ Time Advantage Clock
◊ Next possession indicators
◊ Gloss white enameled captions: “HOME” and “VISITOR”
◊ Operator’s master console with running time display, 10 ft. flexible cords to operate all functions and carrying case required
◊ Control receptacles with covers
◊ Assortment of spare lamps and fuses
◊ Complete set of operating and maintenance instructions
Scoreboard housing shall be of rigid completely enclosed, all aluminum construction, and are provided with brackets for wall mounting. Service access for exchange of lamps of plug-in components is from the front of the housing and no tools shall be required. Exposed exterior surfaces shall be immersion etched and finished in dark non-reflecting enamels with gloss white captions and trim. Color to be selected by Architect.
◊ Receiver for wireless control.
b. Display Modules
LED digit numerals 12 in. high, for time and score and 10 in. high

for period. All LED digits have a life expectancy of over 100,000 operating hours. Each numeral is covered by Lexanâ material protecting them from damage due to stray basketballs and volleyballs. Numerals shall appear amber, red and green on a jet-black background. Bonus arrows and possession arrows are red.

c. Electronic Systems
Electronics to be solid state low voltage encased in completely "plug-in" paks.

d. Battery Operated Control Console with Wireless Transmitter
1) Shall be Model MP-70 with padded carrying case. Requires 120V AC power of battery source and draws 12 watts. Construction shall be an aluminum case 12-3/4" long by 2-1/4" high by 8" deep with 4 rubber slide-resistant feel. Operating features shall include a two-line LCD readout showing information as sent to the scoreboard display as well as constant display of time remaining or time lapsed; a changeable color coded keypad to allow key identification change by sport, numeric key pad, plus and minus keys for quick sequential data entry, a push-type horn button and a positive action rocker switch for the "Time In" and "Time Out" function.
2) Electronic features shall include a program mode allowing change in sport controlled or accommodation of a sport rules change, a memory circuit to retain information if power interrupted and electronic foul memory.
3) Furnished with one battery with charger and one transmitter for battery operated wireless control.
4) Provide one Control Console for each scoreboard.

e. Horn
1) The horn is a special Electronic constant duty scoreboard horn with a decibel level of 100.

f. Power Requirements
1) Model BB-1620-4: 120V.AC, 1 phase, 50/60Hz - 168 watts

g. E.T.L./Electrical Testing Laboratory Approval
1) This scoreboard carries the E.T.L. label signifying this organization's testing and approval as a safe and dependable design.

B. Furnish and deliver as hereinafter specified Fair-Play electronic LED digit shot timers as indicated on Drawings. The shot timers shall be a Model ST-1410-4 LED digit and include all the equipment as hereinafter specified.

1. Shot Timer System

a. ST-1410-4 Timer System
The timer system operates from the MP-70 Scoreboard Control and consists of the following:
◊ Provide a Shot Timer Hand Switch for each Control Console provided.
◊ Display modules with vibrating horn and 18" power cord
◊ 10 Ft. cords w/plugs on each end.

◊ Receiver for wireless control.

b. Shot Timer Construction
The timer display unit shall be constructed of an all metal frame for indoor use and shall be approximately 17" x 20". Approximate wt: 50 lbs.

c. Display Modules
LED digit numerals shall be 12" high. All LED digits have a life expectancy of over 100,000 operating hours. Each numeral is covered by Lexanâ material protecting them from damage due to stray basketballs and volleyballs. Electrical connection to the timer display is by flat flexible printed Mylar circuitry. Insuring proper socket and connector alignment. Numerals shall appear red on a jet black background. Each display incorporates a vibrator horn and comes with 18" power cord.

2.27 DRY TYPE K-RATED TRANSFORMERS

A. Description

1. This Specification describes the design of a copper wound, multi-shielded, three phase, K-factor rated, high efficiency, power conditioning isolation transformer. The power conditioning transformer specified must be a continuous duty rated, 600 volt class, convection cooled, dry type, isolation transformer to support harmonic rich non-linear loads while maintaining safe operating temperatures and shall include superior transverse and common mode noise attenuation. The power conditioning transformer shall meet NEMA TP 1-2002 dry type transformer efficiency standards. In addition, the transformer shall be designed to achieve NEMA TP 1-2002 Table 1-1 efficiencies under K-13 non-linear load at or between 35% to 50% of its rating as outlined in Section G, 10, of this Specification Section.

B. Standards

1. The power conditioning system shall be designed in accordance with applicable portions of the following standards:
   a. NEMA TP 1-2002 Dry Type Distribution Transformer Efficiency Standards.
   b. American National Standards Institute (ANSI C57.110 and C62.41-1991).
   c. Institute of Electrical and Electronic Engineers (IEEE 519-1992).
   d. National Fire Protection Association (NFPA) 70, National Electrical Code (NEC).
   e. Federal Information Processing Standards Publication 94 (FIPS Pub 94).
   f. UL Listed to Standard 1561.
   g. C-UL listed to CSA Standard C22.2, No. 47-M90.

C. Submittals

1. Manufacturer Requirements:
   a. The manufacturer shall be ISO 9001:2008 “Quality Assurance Certified” and shall upon request furnish certification documents.
   b. The manufacturer shall be a United States based manufacturer with at least 15 years experience in design and fabrication K-rated, shielded, power conditioning isolation transformers.

2. Product Data:
   a. The manufacturer shall supply documentation for the installation of the system, including wiring diagrams and cabinet outlines showing dimensions, weights, BTUs, input/output connection locations and required clearances.
   b. Factory test results and design data shall be provided to show compliance with the requirements.

D. Manufacturer's
1. The equipment specified is the Ultra-K, Series 600K, manufactured by Controlled Power Company. Equipment shall be as manufactured by Controlled Power Company, Acme, Siemens, or equal.

E. Input Specifications
1. The nominal AC input voltage rating of the power conditioner shall be 480 VAC 3 phase with sufficient margin to sustain a constant input of +10% without saturation.
2. The nominal operating frequency shall be 60 hertz $\pm$ 3 hertz.
3. The power conditioning transformer primary shall be configured in a three phase delta. Transformers below 500kVA shall include full capacity taps at 2½ % increments, two (2) above and four (4) below the nominal voltage tap.
4. When energized, the current inrush shall not exceed a maximum of 10 times the full load input current for a 1/2 cycle.

F. Output Specifications
1. The nominal AC output voltage rating of the power conditioning transformer shall be 208 VAC wye derived, 60 hertz.
2. The output impedance of the power conditioning transformer shall be 3% - 4% typical.
3. The power conditioning transformer shall be K-13 rated in accordance with: $K = \sum Ih(pu)^2 h^2$
4. The power conditioning transformer shall provide a continuous duty, full load output power as indicated on Drawings.

G. Performance Specifications
1. The output voltage of the power conditioning transformer shall be maintained within $\pm$2.5% or less of nominal, from no load to full load.
2. The overload rating of the power conditioning transformer shall be 500% for 10 seconds, and 1,000% for one cycle.
3. The power conditioning transformer shall add no more than 1% total harmonic distortion to the output waveform under a linear load.
4. Output voltage shall remain sinusoidal with no flat topping when high crest factor (3.0 : 1), non-linear loads are present at the output.
5. The audible noise of the power conditioning transformer shall be no greater than measurements indicated below:
   a. 50 dB for 15 KVA to 112.5 KVA units measured at 1 meter.
   b. 55 dB for 150 KVA to 225 KVA units measured at 1 meter.
   c. 60 dB for 300 KVA to 500 KVA units measured at 1 meter.
6. The power conditioning transformer shall incorporate a solid copper foil, triple electrostatic shield to minimize inner winding capacitance, transient and noise coupling between primary and secondary windings.

7. Transformer shall be triple-shielded and capable of 146dB common mode noise attenuation.
8. Transformer shall be capable of transverse mode noise attenuation of 3 dB down at 10kHz, decaying 20 dB per decade.
9. The power conditioning transformer shall have an efficiency of 98% typical and shall meet NEMA TP 1-2002 dry type transformer efficiency standards on models 15kVA and above.
10. The power conditioning transformer shall be designed to achieve NEMA TP 1-2002 Table 1-1 efficiencies listed below under a K-13 non-linear load at or between 35% to 50% load and at an operating temperature of 75 degrees C.

kVA	Efficiency
15*	97.00%
30	97.50%
45	97.70%
75	98.00%
112.5	98.20%
150	98.30%
225	98.50%
300	98.60%
500	98.70%

*15kVA model efficiency applicable to K4 and K7 loading only.

11. The power conditioning transformer shall incorporate a fused (with front panel mounted, blown fuse lamp indicator) 3 phase, secondary connected, 6 mode spike suppression network. The suppressor shall be comprised of high energy metal oxide varistors with less than a 5 nanosecond response time and a maximum peak current handling capability of 40,000 amps (8x20μsec) per mode. The suppression network system shall remain functional when subjected to ANSI/IEEE C62.41 Category B-3 waveforms. The spike suppression network will increase the transverse mode noise attenuation to 3 dB down at 10kHz, decaying 40 dB per decade.

H. Main Transformer Construction
1. The transformer windings shall be all copper conductor construction, with separate primary and secondary, isolated windings. The transformer shall conform to National Electrical Code, that specifies a separately derived power source. The neutral conductor shall be provided at 2 times the ampacity of the phase conductor.
2. Terminals shall be provided for isolated three phase output conductors, neutral conductor and ground.
3. Output neutral shall be bonded to ground via a removable jumper wire or bus bar.
4. All leads, wires and terminals shall be labeled to correspond with the circuit wiring diagram.
5. Basic Impulse level shall be no less than 10,000 Volts.
6. Mean Time Between Failure (MTBF) shall be no less than 200,000 hours.

7. Grain oriented, M6 grade, silicon transformer steel shall be utilized to provide maximum efficiency. Flux density shall not exceed 15k gauss. Core losses shall be limited to 0.6% or less of the KVA rating.
8. Class N, 200°C insulation system shall be utilized throughout with a maximum temperature rise above ambient of 115°C under a linear load, not to exceed 130°C under non-linear loading per UL 1561.
9. The transformer shall be designed for natural convection cooling.

I. Cabinet Construction
1. The cabinet shall be a NEMA type 2 general purpose, floor mounted, indoor enclosure. Dimensions shall not exceed TABLE 1-2 dimensions below.
2. Cabinets shall be manufactured from 14 gauge steel with base sub-structure suitable for fork lifting.
3. The cabinet shall have a baked on powder coat paint finish with proper pre-treatment.
4. Input and output power connections shall be hardwired to copper stand off bus located behind the front panel of the transformer cabinet. Input and output locations shall be available on either side of transformer cabinet.

J. Environment
1. Temperature: The power conditioning system shall be required to operate without overheating in an ambient temperature range of -20°C to +40°C.
2. Humidity: The power conditioning system shall operate in a relative humidity of 0 to 95% non-condensing.
3. Altitude: The power conditioning system shall operate up to 5000 feet above sea level without de-rating.

K. Warranty
1. Manufacturer shall guarantee the power conditioning transformer to be free from defects in material and workmanship for a period of 2 years following shipment from the factory.

2.28 LIGHTNING PROTECTION

A. Provide a dedicated lighting protection system for the School and a dedicated lighting protection system for the Waste Water Treatment Facility.

B. General:

1. Scope
a. The work covered by this Section of the Specifications consists of providing services of a qualified lightning protection engineer, labor and materials required for the design and installation of a functional and unobtrusive lightning protection system. System shall comply with the latest issue of Underwriters' Laboratories, Incorporated Master Label Code 96A and NFPA Code No. 780 Lightning Protection Systems. At the completion of the installation an Underwriters' Laboratories, Incorporated Master Label shall be furnished to the Owner.

b. If any departure from the Contract Drawings or Shop Drawings covered below are deemed necessary by this Contractor, details of such departures and reasons therefore shall be submitted as soon as practicable to the Architect for approval. No such departures shall be made without prior written approval of the Architect.

2. Quality Assurance

a. The system to be furnished under this Specification shall be the standard product of the manufacturer regularly engaged in the production of lightning protection systems and shall be the manufacturer's latest approved design. The equipment manufacturer shall also be an approved manufacturer. All material specified in this Section is manufactured by Heary Bros. Lightning Protection Company, Inc., 11291 Moore Road, Springfield, New York 14141. Lightning protection shall be as manufactured by Heary Brothers Lightning Protection Company Inc., Boston Lightning Rod Inc., East Coast Lightning Equipment, Inc., or approved equal.

3. Submittals

a. Complete Shop Drawings showing the type, size, and locations for all equipment, grounds and cable routings, shall be submitted to the Architect for approval prior to start of work.

b. Samples and pertinent catalog data shall be submitted to the Architect for approval upon request,

C. Products:

1. Standard

a. All equipment shall be new, the product of a single manufacturer as outlined above, and of a design and construction to suit the application where it is used in accordance with accepted industry standards.

b. Equipment

1) All materials shall be copper or bronze and of the size, weight and construction to suit the application where used in accordance with requirements for Class I structures and as per manufacturer recommendations.

2) Conductors shall be copper, 29 strands, 17 gauge minimum, Heary Bros. Cat. No. HB-29-17C.

3) Air terminals shall be solid, round copper bar of 3/8" minimum diameter. Heary Bros. Cat. No. HB308C, and shall project 10" minimum above the object to be protected. Locate and space according to requirements.

4) Air terminal bases shall be of cast bronze with bolt pressure cable connections and shall be securely mounted with stainless steel screws or bolts. Crimp type connectors are not acceptable.

5) Heary Bros. Cat. No. HB16C, 32C, 38C. and 25C. Bases on built-up tar and gravel roofs shall be secured with a proper adhesive and shall have a minimum surface contact area of 18.5 sq. inches, Cat. No. HB23C.

6) Ground rods shall be a minimum 5/8" in diameter and 10'-0" long. Heary Bros. Cat. No. HB106GR. They shall

be connected to the system with a two-bolt cast bronze clamp. Heary Bros. Cat. No. HB111X, having a minimum length of 1-1/2" and employing stainless steel cap screws.

7) Cable fasteners shall be substantial in construction, electrolytically compatible with the conductor and mounting surface and shall be spaced according to requirements. Heary Bros. Cat. No. HB66C, 72C, 64C.

8) Bonding devices, cable splicers and miscellaneous connectors shall be of cast bronze with bolt pressure connections to cable. Cast or stamped crimp fittings are not acceptable. Splicers similar to Heary Bros. Cat. No. HB57C, 26C, 501C bonding devices similar to Heary Bros. Cat. No. HB54C, 97C, 178B, 57XXC, 42C.

9) Equipment on stacks and chimneys shall be protected from corrosion and sized in accordance with requirements.

10) All miscellaneous bolts, nuts and screws shall be brass, bronze or stainless steel.

D. Execution:

1. Installation
   a. The installation shall be accomplished by an experienced installer. The installer shall work under the direct supervision of a manufacturer as listed above or his authorized representative.
   b. All equipment shall be installed in a neat workmanlike manner in the most inconspicuous manner as possible. The system shall consist of a complete cable network on the roof involving all air terminals, splices and bonds with cable downloads routed concealed in the Building construction in conduit to ground rod.
   c. Downlead cables shall not be brought directly through the roof. Conduit through proper roof flashings shall be utilized for this purpose.
   d. The Electrical Subcontractor shall furnish and install all necessary PVC conduit for concealed down conductors.
   e. Copper equipment shall not be connected to aluminum surfaces except by means of a bi-metal transition fittings. Lead coating is not to be accepted as a bi-metal transition.
2. Coordination
   a. The lightning protection installer will work with other trades to insure a correct, neat and unobtrusive installation.
   b. It shall be the responsibility of the lightning protection installer to assure a sound bond to the main water service and to assure interconnection with other Building ground systems, including both telephone and electrical. Proper arresters shall be installed on the power and telephone service by either the utility or the Electrical Subcontractor as applicable.
3. Completion
   a. The lightning protection installer shall secure and deliver the As-Built Shop Drawings to the Architect for the Owner upon completion of the installation.

2.29 COMMUNICATIONS SYSTEM

A. The Electrical Subcontractor shall be responsible for properly preparing the project for installation by the Communications Integrator, Section 27 10 00, 27 21 33, 27 40 00, 27 50 00 and 27 70 00 as specified.

B. Responsibilities of the Electrical Subcontractor shall include: The Electrical Subcontractor shall be responsible for providing and installing all related Building preparation including, but not limited to: outlet boxes with plaster rings, floor boxes, poke through devices, pathways, power, cableways, J hooks, cable tray including cable tray over each rack and cabinet to facilitate a neat and orderly installation of cables, cable protection, wiremold, surface raceways, cable supports, conduits with bushings, conduit stubs with bushings. Sleeves with bushings (all conduits, stubs, and sleeves, shall be brought to an accessible hallway ceiling or accessible area below floor), backboxes, plaster rings, pull strings, bonding, grounding, core drilling, cutting, patching, fireproofing of penetrations and openings, environmental seals, smoke and fire stopping seals including all conduits, raceways, sleeves, and slots, where cables pass from one location to another, removal and re-installation of ceiling tiles to install concealed cabling, seismic supports, supplementary steel and channels, for a completely operational system as specified. The Electrical Subcontractor shall also accept delivery and properly store and secure all equipment and materials required by the systems integrator. The Electrical Subcontractor shall install all specialized backboxes (clock, speaker, and amplifier) and any exterior antennas provided by the Systems Integrator.

1. The Electrical Subcontractor shall be responsible for providing and installing: conduits from each IDF location back to the MDF location to comply with Code for applicable sound, voice, data and video cabling: conduits from the Point of Demarcation to the MDF location to comply with Code for applicable sound, voice, data and video cabling: conduits from the Video Headend location back to the MDF location to comply with Code for applicable video cabling.

C. Responsibilities of the Communications Integrator for this Section: The Communications Integrator shall be responsible for providing, installing, programming, troubleshooting, training and warranty service of all cabling, terminal equipment, headend equipment specified in this Section for a completely operational system. The Communications Integrator shall furnish all specialized backboxes (clock, speaker, and amplifier) and all exterior antennas to the Electrical Subcontractor for their installation.

2.30 LIGHTING CONTROL SYSTEM

A. Equipment provided under this Section shall be all manufactured by a sole manufacturer. Submittals with multiple manufacturer's will not be accepted.

B. Introduction

1. The work covered in this Section is subject to the requirements in the General Conditions of the Specifications. Contractor shall coordinate the work in this Section with the trades covered in other Sections of the Specification to provide a complete and operable system.

C. System Description

1. Extent of lighting control system work is indicated by Drawings and by the requirements of this Section. It is the intent of this Section to provide an integrated, energy saving lighting control system including Lighting Control Panels, Occupancy Sensors, and Daylighting Controls from a single supplier. Contractor is responsible for confirming that the panels and sensors interoperate as a single system.

D. Quality Assurance

1. Manufacturer's: Firms regularly engaged in the manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
2. Comply with NEC, NEMA, and FCC Emission requirements for Class A applications.
3. UL Approvals: Relay panels and accessory devices are to be UL listed under UL 916 Energy Management Equipment. Configured to order or custom relay panels shall be UL Listed under UL 508, Industrial Control Panels.

E. Submittals

1. Submit manufacturer's data on lighting control system and components including Shop Drawings, detailed point to point wiring diagrams, and floor plans showing occupancy and daylighting sensor locations. Provide typical mounting details for occupancy and daylighting sensors for this application.

F. Manufacturer's

1. This Specification is based upon products from WattStopper. Equipment shall be as manufactured by WattStopper, Lutron, Philips Controls, Cooper, or equal. All substitute equipment proposed as equal to the equipment specified herein, shall meet or exceed the equipment standards. For equipment other than that specified, the contractor shall supply proof that such substitute equipment does in fact equal or exceed the features, functions, performance, and quality of the specified equipment.
2. All references to manufacturer's or supplier's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality. Equivalent equipment (compatible UL Listed) from other manufacturer's may be substituted for the specified equipment.

G. Lighting Control Panels

1. Provide lighting control panels in the locations and capacities as indicated on the plans and schedules. Each panel shall be of modular construction and consist of the following components:
   a. Enclosure/Tub shall be NEMA 1, NEMA 3R, or NEMA 4 as indicated on the plans, sized to accept an interior with 1-8 relays, 1-24 relays and six (6) four pole contactors, or 1-48 relays with six (6) four pole contactors.
   b. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. The panel cover shall have a hinged and lockable door with restricted access to line voltage

section of the panel.

c. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. The interior construction shall provide total isolation of high voltage (class 1) wiring from low voltage (class 2) wiring within the assembled panel. The interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. The panel interiors shall include the following features:

1. Provision for one or two optional control and automation cards.
2. Removable, plug-in terminal blocks with screw-less connections for all low voltage terminations.
3. Individual terminal block, override push button, and LED status light for each relay
4. Switch inputs associated with each relay and group channel shall support two or three wire, momentary or maintained contact switches or 24VDC input from occupancy sensors.
5. Automatic support for occupancy sensor sequence of operation. Low voltage inputs automatically reconfigure when connected to a WattStopper occupancy sensor head. Occupancy sensor shall switch lighting on and off during unoccupied periods but shall not turn lighting off during scheduled occupancy periods.
6. Isolated contacts within each relay shall provide true relay state to the electronics. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems.
7. Automatic sequenced operation of relays reduces impact on the electrical distribution system when large loads are controlled simultaneously.
8. Group, channel, and pattern control of relays shall be provided through a simple button-press interface within the panel. Any group of relays can be associated with a channel for direct on/off control or pattern (scene) control via a simple programming sequence using the relay and channel override push buttons and LED displays.
9. Relay group status for each channel shall be provided through bi-color operation of the LED indicators. Solid red indicates that all relays in the group are on, solid green indicates that the group is in a mixed state, and blinking green indicates that the relays have blink warned and are currently timing out.
10. Each relay and channel terminal block shall provide a 24V pilot light signal. It shall be possible to configure the system for support for any Class 2 pilot light voltage with the use of an auxiliary power supply.
11. Single pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:
    a. Electrical:
        1. 30 amp ballast at 277V

2. 20 amp ballast at 347V
3. 20 amp tungsten at 120V
4. 30 amp resistive at 347V
5. 1.5 HP motor at 120V
6. 14,000 amp short circuit current at 347V

b. Mechanical:
1. Individually replaceable, ½" KO mounting with removable Class 2 wire harness
2. Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel
3. Dual line and load terminals each support two #14 – #12 solid or stranded conductors
4. Tested to 300,000 mechanical on/off cycles
5. Isolated low voltage contacts provide for true relay status feedback and pilot light indication.

c. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.

d. The Dataline wire will be supplied by the equipment manufacturer and will include the manufacturer's name, catalog number printed on the wire jacket. The contractor, at its own expense, will replace an improper dataline wire.

e. Panels shall be digitally addressed and support bi-directional communication between each other and other intelligent field devices specified elsewhere.

H. Advanced Communications, Integration and PC Connectivity

1. Provide an advanced communications network that supports optional features like PC connectivity, TCP/IP connections, advanced programming system documentation, enhanced diagnostics, historical and runtime accumulation, and graphic programming and control.

a. The system shall support the following advanced operating scenarios:
1. Adjustable override periods for after hour use based upon the day of the week.
2. Preemptive override before OFF to prevent blink warning and to start a new override time delay.
3. Allow common areas to remain ON when specific relays in a panel are ON. Egress timer starts a countdown when the last watched relay turns OFF.
4. Master Switch Control with blink option to provide a blink warning and five minute countdown for occupants when a master switch is turned OFF

5. Interior daylighting control to turn OFF lights when available natural light meets occupants' lighting needs. Lights will only come on during occupied periods when enough natural light is not available.
6. Occupancy Sensor Integration: Allows relays to automatically follow occupancy sensors' status, or interlock the sensors with daily schedules (Relays stay ON during scheduled ON time, and follow sensors only during after hours).

b. Communications
1. Each panel shall support RS232 twisted pair and optional RS-485 connections. Either protocol may be used for programming, monitoring, and control. The dataline shall allow simultaneous operation of multiple communications access points to support multiple operator terminals and communications with other Building automation systems.
2. Each panel shall be capable of stand-alone automatic operation and the network shall achieve full distributed processing.
3. All programming shall be accomplished with a Windows based PC running compatible software package.

c. Hardware Features
1. Each communication control card shall be capable of providing all logic, control, runtime data, status information, and communications functions for up to 48 relays in a panel.
2. EEPROM power loss memory and clock holdup time: 30 days
3. Self-diagnostics: Automatic diagnostics on all memory, input/output card modules, relays, and dataline.
4. Clock: Digital with time, day of week, and date. Automatic leap year compensation. Programmable Daylight Savings Time and Standard Time adjustment.

d. WinControl Software
1. Schedules
a. Each communication control card shall support up to 24 unique weekly schedules out of a total of 1,000 available per system. Each schedule shall allow up to eight events per day for a repeating seven day week.
b. Up to 32 holidays may be defined for any specific date. On that date any of the three holiday schedules may be assigned.
c. Relays may be programmed to switch to a different weekly schedule on any specific date, and then revert back to normal at another time. This allows for future schedule changes to be programmed ahead of time.
d. "Spring Ahead" and "Fall Back" dates for daylight savings time changes may be entered full two years ahead. Software also supports the ability to "Auto fill" in the next two occurrences of

each of these dates.

2. Time Delay / Blink Warning
   a. Used during unoccupied periods, assignable for each relay.
      (1) Time delays from 2 to 1,440 minutes.
      (2) Blink Warning: 1-second OFF blink followed by a 5 minute grace period before OFF.
      (3) An optional second blink warning one minute before OFF.
   b. Operates automatically for all scheduled OFFs and time delay overrides.
   c. Occupant overrides may be entered before the blink warning to prevent a scheduled blink and shutdown.
3. Analog Photocell Configuration
   a. Enable any group switch card input (eight per group switch card) to act as an analog input into the panel for use with photocells or other analog devices
   b. Select the photocell from list of available types including:
      (1) Indoor, 0 - 500 foot candles
      (2) Indoor, 0 - 50 foot candles
      (3) Skylight, 0 - 6000 foot candles
      (4) Outdoor, 0 - 200 foot candles
   c. Establish trigger parameters for each analog input with:
      (1) Separate on and off set points
      (2) Separate on and off time delays
      (3) Load to be controlled by the input
4. A total of 32 sets of trigger parameters may be established per panel
5. Analog Photocell Monitoring
   a. Actual foot candle light levels per photocell and the current trigger state of the loads may be read using the Operators Software.
6. Telephone Override
   a. Each relay shall respond to up to eight different telephone override codes. Maximum of 9999 telephone codes can be programmed.
7. Runtime Counters for Each Relay
   a. Cumulative runtime (up to 31 years) and number of cycles (up to 17 million) since last reset. User re-settable.
   b. Daily runtime for the current day and each of the prior 40 days.
   c. Monthly runtime for current and 14 prior months.
8. Activity Logs
   a. Store previous relay events including the time, new state, and cause for the change in state.
   b. Annunciate over the dataline and RS232 port when the table is 25%, 50%, 75% and 100% full.

I. Operator's Software
   1. User programming and editing may be conducted both online or offline in a Windows based software application.
   2. Data shall be entered through a simple menu-driven user interface.
   3. The software shall simplify integration with other software products by allowing the lighting control manufacturer's components to be embedded into other Windows applications. These features shall include the following:
      a. BACnet connectivity with optional WebLink.
      b. Drag and Drop interface programming supported throughout the program.
   4. Basic operating software provides the following:
      a. Site wiring documentation for all connected relay panels and system components.
      b. English descriptions of each relay's circuit designation, circuit description, switch and calculated load.
      c. RS232 and TCP/IP Connection to Lighting Control Panel
      d. Monitor/Control all relays. Software shall show actual relay states, with an optional menu showing how and when the relay state occurred, and when next scheduled to change.
      e. Simulate all functions.
   5. System Parameters
      a. System software to be sized based appropriately for the system – 250, 500, 750 or unlimited relays. Any number of sites may be programmed from a single software package (based on hard drive space).
      b. Passwords Matrix Features allowed per site.
      c. User defines functions accessible for each password (Document, Program, Initialize, Transfer from PC, Transfer to PC, Control, Simulate/Test).
      d. Configure software to automatically contact remote sites using a modem or I/P address.
   6. Other Features
      a. Online help brings up a context sensitive help screen.
      b. One step menu option to back up all site information to a backup drive.
      c. The software shall include Trends and Relay Runtime Analysis that will allow the operator to analyze the operation of specific areas and identify those exceeding normal runtimes. Individual relays may be assigned a kWh weighted value or simply analyzed on a runtime basis. In both cases, the relays may be assigned to logical groups and plotted for the last 30 days or 12 months.
   7. System Design Capability
      a. From the lighting control system software database, the software shall be able to automatically create a system single line Drawing, panel schedules and Specifications that can be exported in DXF format for use in standard CAD Drawings.

J. Central Programming, Monitoring, and Control Work Station
   1. Desktop Computer (PROVIDED BY OWNER) work station will provide monitoring, programming and control of the system.

2. The computer will be a Pentium 4 class personal computer with monitor for enhanced color graphics display. The system shall be shipped complete with all memory, cables, and peripheral devices. The complete system shall be factory tested prior to shipment. The system shall include at a minimum:
    a. 3 GHz, Intel Pentium 4 based personal computer
    b. 17” SVGA flat panel color monitor
    c. 60 GB hard disk
    d. 256 MB RAM
    e. CD +R/+W drive
    f. Lighting control software, WinXP Pro

K. Ethernet Multi-user Connectivity - Weblink
1. System Description
    a. A network appliance will provide multi-user, simultaneous access to the lighting system using standard TCP/IP and the WinControl software.
    b. All IT infrastructure that is required for connectivity shall be specified elsewhere and is not considered part of the lighting control system requirements.
    c. The network appliance will include the following hardware:
        1. Ethernet, Serial and Parallel port
        2. Optional 56K BAUD internal modem
        3. Video graphics card
2. Features
    a. Multiple users (each with a licensed copy of WinControl) will be able to simultaneously connect to the IP address of the WebLink.
    b. Users may be connected via an Intranet, or Internet depending upon network security limitations.
    c. Provide the capability to monitor the status of each relay and to override each relay using only a web browser
    d. A single user may connect using WinControl, via the internal modem of the WebLink.
    e. The WebLink will provide all the features of a direct connected site to the simultaneous users.
3. BACnet Integration with Building Automation System
    a. Provide an Ethernet or BACnet IP connection for connectivity to the BAS
    b. Each lighting control panel shall be exposed to the BAS as a BACnet Device with an individual BACnet Device ID.
    c. The lighting control relays within each panel shall be exposed as BACnet Binary Output objects with read/write capability for control and status monitoring.
    d. System group codes shall likewise be exposed as Binary Output objects and shall provide capability for a single command from the BAS to control multiple relays in multiple panels simultaneously via the lighting control network.
    e. To facilitate a seamless integration with the BAS, the BACnet object Description Property fields shall be automatically populated with the relay, group code, and panel text descriptions from the lighting control system database as created by the WinControl software.

L. Digital Dataline Switches

1. Intelligent digital switching shall be provided operating on the dual twisted pair communication wire. Switches shall be available in single, dual, quad, or octal (1-button, 2-button, 4-button, or 8-button) designs. The single, dual, and quad devices shall mount in a standard single-gang box, the octal version in a two-gang box.
   a. Each button shall be individually programmable. Programming of buttons shall not require the use of a computer or other programming device. It shall be possible to assign relays or channels to buttons using a simple button press interface. Each button can control any one of the following options:
      1. Any individual relay in any single panel.
      2. Any group of relays in any single panel.
      3. Any group of relays in the system (via network clock, Automation Appliance, or WinControl software package).
   b. For applications that require pattern switching, buttons shall function as a scene control using an ON/OFF/Not Controlled pattern of relays instead of the normal All ON/OFF.
   c. Switches shall be constructed of non-breakable Lexan on all exposed parts and shall include a matching screw-less Lexan wall plate.
   d. Individual buttons shall have a removable clear cover to allow standard 9 mm (3/8 inch) labeling tape to be used to identify the controlled loads.
   e. Each switch shall use a bi-color LED pilot light for the individual buttons to indicate status of the controlled relay or group of relays. LED indications are Red for All ON, Green for Mixed State (some relays in the group ON and others OFF), and No LED for All OFF.
   f. Switch LED pilot lights shall flash green to indicate impending off sweep during the five-minute grace period following blink warning of the lights. Once the button is pressed, the LED will change to Red to acknowledge the occupant's override command to keep lights ON.
   g. Multiple dataline switches programmed to control the same relay or relay group shall indicate the same status automatically.
   h. Each switch shall also include a locator light illuminating the switch for easy location in the dark.
   i. The dual, quad, and octal switches shall all include a single master button that will override all relays controlled by the individual buttons OFF, or Restore them to their original state. Each switch's master button configuration can be altered to perform a Master ON/OFF, OFF Only, or Disabled function if desired.
   j. Switches can be configured to follow a "Cleaning" scenario. This specific scenario shall prevent the cleaners from overriding OFF any relays previously turned ON by an occupant.
   k. Each switch is available in a Key lock override version. Once a key is inserted, the individual buttons will function for five minutes.

M. Occupancy Sensors

1. Product Numbers:

a. Ceiling sensors: WT-605, WT-600, WT-1105, WT-1100, WT-2205, WT-2200, WT-2250, WT-2255, W-500A, W-1000A, W-2000A, W-2000H, UT-300, UT-305, UT-355, WPIR, DT-200, DT-205, DT-300, DT-305, DT-355, CX-100, CX-105, CI-200, CI-205, CI-300, CI-305, CI-355, CI-12, CI-24
b. Wall switch sensors: PW-100, PW-100-24, PW-200, WS-250, WD-170, WD-180, WD-270, WD-280, WN-100-120, WN-100-277, UW-100, UW-100-24, UW-200, DW-100, DW-100-24, DW-200.
c. Power and Auxiliary Packs: BZ-50, BZ-150, C120E-P, C277E-P, S120/27-P, AT-120, AT-277
d. Low Temperature: CB-100
e. Digital Time Switches: TS-400, TS-400-24

2. Wall switch sensors shall be capable of detection of occupancy at desktop level up to 300 square feet, and gross motion up to 1000 square feet.
3. Wall switch sensors shall accommodate loads from 0 to 800 watts at 120 volts; 0 to 1200 watts at 277 volts and shall have 180˚ coverage capability.
4. Wall switch products shall utilize Zero Crossing Circuitry which increases relay life, protects from the effects of inrush current, and increases sensor's longevity.
5. Wall switch sensors shall have no leakage current to load, in manual or in Auto/Off mode for safety purposes and shall have voltage drop protection.
6. Where specified, wall switch sensors shall provide a field selectable option to convert sensor operation from automatic-ON to manual-ON.
7. Where specified, vandal resistant wall switch sensors shall utilize a hard lens with a minimum 1.0mm thickness. Products utilizing a soft lens will not be considered.
8. Passive infrared sensors shall utilize Pulse Count Processing and Detection Signature Processing to respond only to those signals caused by human motion.
9. Passive infrared sensors shall provide high immunity to false triggering from RFI (hand-held radios) and EMI (electrical noise on the line).
10. Passive infrared sensors shall have a multiple segmented Fresnel lens, in a multiple-tier configuration, with grooves-in to eliminate dust and residue build-up.
11. Where specified, passive infrared ultrasonic and dual technology sensors shall offer daylighting foot-candle adjustment control and be able to accommodate dual level lighting.
12. Dual technology sensors shall be wall mounted, corner mounted or ceiling mounted in such a way as to minimize coverage in unwanted areas.
13. Dual technology sensors shall consist of passive infrared and ultrasonic technologies for occupancy detection. Products that react to noise or ambient sound shall not be considered.
14. Ultrasonic sensors shall utilize Advanced Signal Processing to adjust the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled space.
15. Ultrasonic operating frequency shall be crystal controlled at 25 kHz within ± 0.005% tolerance, 32 kHz within ± 0.002% tolerance, or 40 kHz ± 0.002% tolerance to assure reliable performance and eliminate sensor

cross-talk. Sensors using multiple frequencies are not acceptable.

16. All sensors shall be capable of operating normally with electronic ballasts, PL lamp systems and rated motor loads.
17. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.
18. All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.
19. In the event of failure, a bypass manual override shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall divert to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.
20. All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.
21. Where specified, sensor shall have an internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options. Sensors utilizing separate components or specially modified units to achieve this function are not acceptable.
22. All sensors shall have UL rated, 94V-0 plastic enclosures.
23. Circuit Control Hardware - CU
    a. Control Units - For ease of mounting, installation and future service, control unit(s) shall be able to externally mount through a 1/2" knock-out on a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer to provide low-voltage power. Control unit shall provide power to a minimum of two (2) sensors.
    b. Relay Contacts shall have ratings of:
       13A - 120 VAC Tungsten
       20A - 120 VAC Ballast
       20A - 277 VAC Ballast
    c. Control wiring between sensors and controls units shall be Class II , 18-24 AWG, stranded U.L. Classified, PVC insulated or TEFLON jacketed cable suitable for use in plenums, where applicable.
    d. Minimum acceptable wire gauge from the circuit control hardware relays shall be #14 AWG.

N. Classroom Lighting Controls

1. The Lighting Control and Automation system as defined under this Section covers the following equipment:
    a. Digital Room Controllers – Self-configuring, digitally addressable one, two or three relays controllers with 0-10 volt control for ballasts (if applicable) and single relay application-specific plug load controllers.
    b. Digital Occupancy Sensors – Self-configuring, digitally addressable and calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
    c. Digital Switches – Self-configuring, digitally addressable pushbutton switches, dimmers, and scene switches with two-way

active infrared (IR) communications.

d. Digital Photosensors – Single-zone closed loop and multi-zone open loop daylighting sensors with two-way active infrared (IR) communications can provide switching or dimming control for daylight harvesting.

e. Configuration Tools – Handheld remote for room configuration provides two way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet away. Unit to have Organic LED display, simple pushbutton interface, and allow send and receive of room variables and store of occupancy sensor settings. Computer software also customizes room settings.

2. Digital Wall or Ceiling Mounted Occupancy Sensor System

a. Wall or ceiling mounted (to suit installation) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor. Furnish the Company's system which accommodates the square-foot coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors and accessories which suit the lighting and electrical system parameters.

b. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:

1. Digital calibration and pushbutton programming for the following variables:
   Sensitivity – 0-100% in 10% increments
   Time delay – 1-30 minutes in 1 minute increments
   Test mode – Five second time delay
   Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
   Walk-through mode
   Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
2. One or two RJ-45 port(s) for connection to DLM local network.
3. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
4. Device Status LEDs including:
   PIR Detection
   Ultrasonic detection
   Configuration mode
   Load binding
5. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
6. Manual override of controlled loads.

c. Units shall not have any dip switches or potentiometers for field settings.

d. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.

e. Product Numbers: LMPX, LMDX, LMPC, LMUC, LMDC

3. Digital Wall Switches
   a. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration; white; compatible with wall plates with decorator opening. Wall switches shall include the following features:
      1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
      2. Removable buttons for field replacement with engraved buttors and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
      3. Red configuration LED on each switch that blinks to indicate data transmission.
      4. Blue Load/Scene Status LED on each switch button with the following characteristics:
         Bi-level LED
         Dim locator level indicates power to switch
         Bright status level indicates that load or scene is active
      5. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
      6. Two RJ-45 ports for connection to DLM local network.
      7. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required to achieve multi-way switching.
      8. The following switch attributes may be changed or selected using a wireless configuration tool:
         a. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
         b. Individual button function may be configured to Toggle, On only or Off only.
         c. Individual scenes may be locked to prevent unauthorized change.
         d. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
         e. Ramp rate may be adjusted for each dimmer switch.
         f. Switch buttons may be bound to any load on a room controller and are not load type dependant; each button may be bound to multiple loads.
      9. Product Numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101.
4. Room Controllers
   a. Room Controllers automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room Controllers shall be provided to match the room lighting load and control requirements. The controllers will be simple to install and will not have, dip switches, potentiometers or require special configuration. The control units will include the following features:
      1. Automatic room configuration to the most energy-

efficient sequence of operation based upon the devices in the room.

2. Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf unit without requiring any configuration or setup.
3. Device Status LEDs to indicate:
   Data transmission
   Device has power
   Status for each load
   Configuration status
4. Quick installation features including:
   a. Standard junction box mounting
   b. Quick low voltage connections using standard RJ-45 patch cable
5. Plenum rated
6. Manual override and LED indication for each load
7. Dual voltage (120/277 VAC, 60 Hz)
8. Zero cross circuitry for each load.

b. On/Off Room Controllers shall include:
   1. One or two relay configuration
   2. Efficient 150 mA switching power supply
   3. Three RJ-45 DLM local network ports
   4. Discrete model listed for connection to receptacles, for occupancy-based control of plug loads within the space.
      One relay configuration only
      Automatic-ON/OFF configuration
   5. Product Numbers: LMRC-101, LMRC-102, LMPL-101

c. On/Off/Dimming enhanced Room Controllers shall include:
   1. Real time current monitoring
   2. One, two or three relay configuration
   3. Efficient 250 mA switching power supply
   4. Four RJ-45 DLM local network ports.
   5. One 0-10 volt analog output per relay for control of compatible ballasts and LED drivers.
   6. The following dimming attributes may be changed or selected using a wireless configuration tool:
      Establish preset level for each load from 0-100%
      Set high and low trim for each load
      Set lamp burn in time for each load up to 100 hours
   7. Discrete model listed for connection to receptacles, for occupancy-based control of plug loads within the space.
      One relay configuration only
      Automatic-ON/OFF configuration
   8. Product Numbers: LMRC-211, LRMC-212, LRMC-213

5. Digital Photosensors

a. Digital photosensors work with room controllers to provide automatic switching or dimming daylight harvesting capabilities for any load type connected to a room controller. Closed loop photosensors measure the ambient light in the space and control a single lighting zone. Open loop photosensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones. Photosensors shall be interchangeable

without the need for rewiring.

b. Digital photosensors include the following features:
   1. An internal photodiode that measures only within the visible spectrum, and has a response curve that closely matches the photopic curve. The photodiode shall not measure energy in either the ultraviolet or infrared spectrums. The photocell shall have a sensitivity of less than 5% for any wavelengths less than 400 nanometers or greater than 700 nanometers.
   2. Sensor light level range shall be from 1-10,000 footcandles (fc).
   3. The capability of switching one-third, one-half or all lighting ON and OFF, or raising or lowering lighting levels, for each controlled zone, depending on the selection of room controller(s) and load binding to room controller(s).
   4. For switching daylight harvesting, the photosensor shall provide a deadband or a separation between the “ON Setpoint” and the “OFF Setpoint” that will prevent the lights from cycling after they turn off.
   5. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a user-selectable minimum level.
   6. Optional programmable wall switch override to allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise and lower lighting levels for a selected period of time or cycle of occupancy.
   7. Infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.
   8. Red configuration LED that blinks to indicate data transmission.
   9. Blue status LED indicates test mode, override mode and load binding.
   10. Recessed switch to turn controlled load(s) ON and OFF.
   11. One RJ-45 port for connection to DLM local network.
   12. An adjustable head and a mounting bracket to accommodate multiple mounting methods and Building materials. The photosensor may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox.

c. Open loop digital photosensors include the following additional features:
   1. An internal photodiode that measures light in a 60 degree angle cutting off the unwanted light from the interior of the room.
   2. Automatically establishes setpoints following calibration using a wireless configuration tool or a PC with appropriate software.

3. A proportional control algorithm for dimming daylight harvesting with a “Setpoint” to be maintained during operation.
4. Product Number: LMLS-500.

6. Room Network (DLM Local Network)
   a. The DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a Building. Digital room devices connect to the network using CAT 5e cables with RJ-45 connectors which provide both data and power to room devices. Features of the DLM local network include:
      1. Plug n’ Go automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
      2. Simple replacement of any device in the network with a standard off the shelf unit without requiring commissioning, configuration or setup.
      3. Push n’ Learn configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
      4. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.

O. Configuration Tools
   1. A configuration tool facilitates optional customization of DLM local networks, and is used to set up open loop daylighting sensors. A wireless configuration tool features infrared communications, while PC software connects to each local network via a USB interface. Provide two (2) handheld commissioning tools, one (1) for Electrical Subcontractor, one (1) for Owner.
   2. Features and functionality of the wireless configuration tool shall include:
      a. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.
      b. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
      c. Read, modify and send parameters for occupancy sensors, daylighting sensors, room controllers and buttons on digital wall switches.
      d. Save up to nine occupancy sensor setting profiles, and apply profiles to selected sensors.
      e. Temporarily adjust light level of any load(s)on the local network, and incorporate those levels in scene setting.
      f. Adjust or fine-tune daylighting settings established during auto-commissioning and input light level data to complete commissioning of open loop daylighting controls.
   3. Product Numbers: LMCT-100 DLM.

P. Category 5E Cable

1 Category 5e cable shall be provided by lighting control manufacturer.

Q. Emergency Lighting Control Panel

1. Where indicated, lighting control panels designated for control of emergency lighting shall be provided with factory installed provision for automatic by pass if relays controlling emergency circuits upon loss of normal power. Panels shall be properly listed and labeled for use on emergency ligting circuits and shall meet the requirements of UL924 and NFPA 70 – Article 700.

R. Support Services

1. System Start Up and Commissioning
   a. Manufacturer shall provide a factory authorized technician to confirm proper installation and operation of all lighting control system components. The startup requirement is intended to verify:
      1) That all occupancy and daylighting sensors are located, installed, and adjusted as intended by the factory and the contract documents.
      2) The occupancy sensors and daylighting sensors are operating within the manufacturer's Specifications.
      3) The sensors and relay panels interact as a complete and operational system to meet the design intent.
   b. Manufacturer to provide a written statement verifying that the system meets the above requirements.
2. System Training
   a. Manufacturer shall provide factory authorized technician to train owner personnel in the operation, programming and maintenance of the lighting control system including all occupancy sensors and daylighting controls.
3. System Programming
   a. Manufacturer shall provide system programming including:
      1) Wiring documentation.
      2) Switch operation.
      3) Operating schedules.

2.31 SURGE PROTECTIVE DEVICES (SPD's)

A. Scope

1. The Contractor shall furnish and install the Surge Protective Device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein and as shown on the Contract Drawings. To maximize performance and reliability and to obtain the lowest possible let-through voltages, the ac surge protection shall be integrated into electrical distribution equipment; switchboard, emergency panelboards, optional standby emergency panelboards, and the computer panelboards.

B. References

1. SPD units and all components shall be designed, manufactured, and tested in accordance with the latest applicable UL standard (ANSI/UL 1449 3rd Edition).

C. Submittals – For Review/Approval
   1. The following information shall be submitted to the Engineer:
      a. Provide verification that the SPD complies with the required ANSI/UL 1449 3rd Edition listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL). Compliance may be in the form of a file number that can be verified on UL's website or on any other NRTL's website, as long as the website contains the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR), and Nominal Discharge Current (I_n).
   2. Where applicable the following additional information shall be submitted to the engineer:
      a. Descriptive bulletins
      b. Product sheets

D. Submittals – for Construction
   1. The following information shall be submitted for record purposes:
      a. Final As-Built Drawings and information for items listed shall incorporate all changes made during the manufacturing process.

E. Qualifications
   1. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
   2. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
   3. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
   4. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

F. Manufacturer's
   1. Eaton / Cutler-Hammer products, Current Technologies, Liebert, or equal.
   2. The listing of specific manufacturer above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturer listed above is not relieved from meeting these Specifications in their entirety.

G. Voltage Surge Suppression - General
   1. Electrical Requirements
      a. Unit Operating Voltage – Refer to Drawings for operating voltage and unit configuration.
      b. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 115% of the nominal system operating voltage.
      c. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the switchboard and computer panelboards. The system shall not utilize silicon avalanche diodes, selenium cells,

air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.

d. Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

	Protection Modes			
Configuration	L-N	L-G	L-L	N-G
Wye	●	●	●	●
Delta	N/A	●	●	N/A
Single Split Phase	●	●	●	●
High Leg Delta	●	●	●	●

e. Nominal Discharge Current (I_n) – All SPDs applied to the distribution system shall have a 20kA I_n rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an I_n less than 20kA shall be rejected.

f. ANSI/UL 1449 3rd Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 3rd Edition VPR for the device shall not exceed the following:

MODES	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	700	1200	1500
L-L	1200	2000	3000

2. SPD Design

a. Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

b. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.

c. Electrical Noise Filter – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this Specification shall not be accepted.

d. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.

e. Monitoring Diagnostics – Each SPD shall provide the following integral monitoring options:

1. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.
    a. For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.
    b. For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.
    c. The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.
2. Remote Status Monitor – The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.
3. Audible Alarm and Silence Button – The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.
4. Surge Counter – The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of 50 ± 20A occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.
    a. The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored.

The surge counter's memory shall not require a backup battery in order to achieve this functionality.

f. Overcurrent Protection

1. The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

g. Fully Integrated Component Design – All of the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.

h. Safety Requirements

1. The SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts and shall be maintenance free. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

H. System Application

1. The SPD applications covered under this Section include the switchboard, emergency panelboards, optional standby emergency panelboards, and the computer panelboards assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.

2. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
CATEGORY	Application	Per Phase	Per Mode
C	Switchboard	250 kA	125 kA
A	Computer Panelboards	120 kA	60 kA
A	Emergency Panelboards and Optional Standby Emergency Panelboards	120 kA	60 kA

3. SPD Type – All SPDs installed on the line side of the service entrance disconnect shall be Type 1 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

I. Switchboard, Emergency Panelboards, Optional Standby Emergency Panelboards, and the Computer Panelboards Requirements

1. The SPD application covered under this Section includes computer panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.
   a. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
   b. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
   c. The panelboard shall be capable of re-energizing upon removal of the SPD.
   d. The SPD shall be interfaced to the panelboard via a direct bus bar connection.
   e. The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard.
   f. The SPD shall be of the same manufacturer as the panelboard.
   g. The complete panelboard including the SPD shall be UL67 listed.
2. Switchboard Requirements
   a. The SPD application covered under this Section is for the switchboard location. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.
   b. The SPD shall be of the same manufacturer as the switchboard.
   c. The SPD shall be factory installed inside the switchboard at the assembly point by the original equipment manufacturer
   d. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.
   e. The SPD shall be integral to switchboard as a factory standardized design.
   f. All monitoring and diagnostic features shall be visible from the front of the equipment.

J. Factory Testing
1. Standard factory tests shall be performed on the equipment under this Section. All tests shall be in accordance with the latest version of NEMA and UL standards.

K. Installation
1. The Contractor shall install all equipment per the manufacturer's recommendations and the Contract Drawings.

L. Warranty
1. The manufacturer shall provide a full ten (10) year warranty from the date of shipment against any SPD part failure when installed in compliance with manufacturer's written instructions and any applicable National or Local Code.

2.32 THEATRE AND STAGE EQUIPMENT

A. The Electrical Subcontractor shall be responsible for the following:
1. Install theatrical lighting equipment as furnished by Section 11 61 00.
2. Provide all wiring and conduit to connect all theatrical lighting equipment as furnished by Section 11 61 00.

B. The Electrical Subcontractor shall be responsible for properly preparing the project for installation by the Theatre and Stage Equipment Integrator, Section 11 61 00 as specified.

1. Responsibilities of the Electrical Subcontractor shall include: The Electrical Subcontractor shall be responsible for providing and installing all related Building preparation including, but not limited to: outlet boxes, pathways, power, cableways and J hooks to facilitate a neat and orderly installation of cables, cable protection, surface raceways, cable supports, conduits with bushings, conduit stubs with bushings. Sleeves with bushings (all conduits, stubs, and sleeves, shall be brought to an accessible hallway ceiling or accessible area below floor), back boxes, pull strings, bonding, grounding, core drilling, cutting, patching, fireproofing of penetrations and openings, environmental seals, smoke and fire stopping seals including all conduits, raceways, sleeves, and slots, where cables pass from one location to another, removal and re-installation of ceiling tiles to install concealed cabling, seismic supports, supplementary steel and channels, for a completely operational system as specified. The Electrical Subcontractor shall also accept delivery and properly store and secure all equipment and materials required by the Theatre and Stage Equipment Integrator. The Electrical Subcontractor shall install all specialized back boxes.

2.33 SHORT CIRCUIT/COORDINATION/SELECTIVE COORDINATION STUDY

A. The Study shall be conducted by the switchgear manufacturer.

B. The Study work shall be conducted under the applicable Standards of the American National Standards Institute (ANSI) and the National Electrical Code (NEC). Specifically, the following standards shall apply:

ANSI-C37.010-1972 Standard Application Guide for AC High Voltage Circuit Breakers.

ANSI-C37.5-1969 Calculation of Fault Currents for Application of Power Circuit Breaker Rated on a Total of Current Basis.

ANSI-C37.13-1963 Low Voltage AC Power Circuit Breakers (600 Volt Insulation Class).

C. The basic scope of the Study is the power system, from the power supplier's service point, through the main secondary distribution system. The studies organization shall identify in its proposal the limits of the system that will be studied.

D. The Study organization shall prepare a single-line diagram of the power system. This diagram shall identify all components considered in the Study and the ratings of all power devices. (This includes, but is not limited to, transformers, circuit breakers, relays, fuses, busses and cables). Reference numbers shall be used on the diagram related to key items in the report. ANSI device function numbers shall be used on protective relays.

E. Short Circuit Study:
   1. A Short Circuit Study shall be performed which shows the momentary and interrupting fault duties on each bus shown on the single line diagram. A computer shall be used to perform calculations on all 3 phase faults. In addition, an impedance listing shall be prepared showing bus-to-bus impedance values reduced to a common MVA base referenced to a single-line diagram for ease in reviewing data.
   2. Study each fault interrupting device related to the calculated duty and recommend changes when appropriate.
   3. The Study shall start from utility incoming switches and shall extend through to all panelboards.

F. Coordination and Selective Coordination Study
   1. The Study organization shall perform a comprehensive protection device coordination and selective coordination Study covering all devices identified on the single line diagram. Using a practical compromise between protection of electrical equipment and coordination of devices "downstream", provides settings for all adjustable protective devices shown on the diagram. Selective coordination Study shall be provided as per National Electrical Code Article 700.
   2. Study the application of devices versus system ends and recommend new or additional devices that are needed for adequate protection.
   3. Prepare time/current coordination curves to illustrate the protection and coordination achieved with the recommended settings of protective devices. These curves shall reflect the following (where applicable):
      Appropriate NEC protection points
      Appropriate ANSI protection points
      Magnetizing in-rush points of transformers
      One-line diagram of the system identifying the device plotted
      Short circuit current levels used for construction

G. The Study organization shall submit three (3) bound copies of a report which shall contain the following information:
   1. An executive summary which identifies all significant problems and all recommendations for significant equipment changes.
   2. A tabulation of all protective devices identified on the one-line diagram which their ratings compares with respective fault duty as calculated in the Study.
   3. A tabulation of the settings recommended on all adjustable protective devices with references to the single-line diagram and to coordination curves.
   4. Copies of all time/current coordination curves developed in the Study.
   5. The analysis of problems that lead to specific recommendations included in the executive summary.
   6. The single-line diagram of the system studies, including all ratings, identifications described.
   7. Copies of all computer results referenced to the single-line diagram and the impedance listings.
   8. A ground fault Study for all breakers specified with ground fault, including the associated zero sequence impedance diagrams.

H. Short circuit and ground fault Study shall be submitted with panelboard Shop Drawings submission to verify that available fault currents fall within panelboard/

breaker ratings. Coordination Study may follow, but shall be submitted with the switchboard Shop Drawing submission.

I. Necessary field studies shall be accomplished at no additional expense to the contract.

2.34 SMALL GROUP SEMINAR DIMMING SYSTEM

A. Part 1 – General
1. Summary:
a. Work Included: The work of this Section shall cover all labor, materials, and equipment to furnish Central Dimming Controls herein specified, including:
1. Lighting Controllers with Integrated Dimmers and Switches
2. Lighting Control System Processors
3. Lighting Control System User Interfaces
a) Keypads
b) Touch Panels
c) Web Based Interfaces
d) Lighting Control System Software
4. Lighting Control Communications Network
b. Complete System: The Contractor shall provide all items necessary for a complete, safe, fully functional system as described herein including all tools, labor and supervision, even though they may not be specifically enumerated.
1. Any errors, omissions or ambiguities do not relieve the Contractor of this responsibility, but shall be brought to the attention of the Engineer for clarification.
2. The Contractor shall be responsible for acquiring, installing, wiring and coordination of all components and equipment.
3. The Contractor shall furnish all conduit, wire, connectors, hardware and other materials necessary for a complete and properly functional lighting control and dimming system as specified.
c. Related Sections:
1. Section 12 24 00 - Window Treatments: Window treatments controlled by the Lighting Control System.
2. Section 26 00 00 – Lighting Control System.
3. Section 26 00 00 – Wiring Devices.
4. Section 26 00 00 – Lighting Fixtures including Lamps and Ballasts.
2. Administrative Requirements
a. Coordination:
1. Contractor shall maintain accurate, As-Built Panel Schedules detailing connection and type of lighting loads in the system.
a) Schedules shall detail, at a minimum:
1) Circuit ID, Number, Or Designation.
2) Actual Connected Load, Voltage, and Load Type Per Circuit.
3) Clear Designation Of Emergency Loads,

Where Applicable.

4) Circuits and Their Respective Control Zones.

b) Panel Schedules shall be indexed on a per panel per dimmer/ relay basis

c) Panel Schedules shall be updated and provided to the Manufacturer of the Lighting Control System no later than (30) days prior to commissioning.

3. Submittal Requirements

a. Submittals for Review: The manufacturer shall provide Submittals for approval prior to fabrication of the equipment, in quantities and schedule as defined by Section 01 33 00. A set of Drawings shall be returned, appropriately marked, as the approval document. Submittals for Review shall include:

1. Product Data:

a) Bill of Materials

1) Bill of Materials shall include all components in the system and shall include quantity, description, and model number.

2) Components shall be logically grouped by assembly (station, panel, or device)

b) Manufacturer's catalog cut sheets for standard equipment.

1) Cut sheets must contain full information on dimensions, and construction, applications, to permit proper evaluation

2) Cut sheets must be properly identified as to their intended use.

3) Options or variations must be clearly noted.

c) A copy of the Manufacturer's warranty document for this project.

2. Shop Drawings:

a) Full system schematics and riser diagram(s) illustrating interconnection of system components, including:

1) Wiring Requirements.

2) Power Feeds.

3) Back Box Sizes.

4) Any Special Installation Considerations.

b) Load Schedules Indexed By Panel, Clearly Indicating:

1) Circuit ID, Number, Or Designation.

2) Actual Connected Load, Voltage, and Load Type per Circuit.

3) Clear Designation Of Emergency Loads, Where Applicable.

4) Circuits And Their Respective Control Zones.

3. Specification Conformance: Clearly indicate one of the

following conditions:

a) The equipment and systems submitted conform exactly to Project Specifications and Drawings.

b) The equipment and systems submitted meet the intent of the Specification via an alternate means.

1) Provide a detailed statement indicating paragraph by paragraph and line by line wherein the equipment submitted deviates from the Specifications.

2) Note all variations from the specified system on the Shop Drawings in ¼" high bold notations.

3) Provide a narrative confirming specified function and detailing alternate means for achieving specified function.

b. Submittals for Project Record: The Manufacturer shall provide submittals for Project Record as defined by Section 01 78 00. Submittals for Project Record shall include:

c. Warranties: All equipment shall be warranted free of defects in materials and workmanship.

1) All materials provided will be covered for a period of 2 years following date of commissioning.

a) The warranty shall cover 100% of the parts and manufacturer's labor costs required during the warranty period, which are directly attributable to the manufacturer.

b) Warranty coverage shall begin on the date that the equipment is energized.

2) Operations and Maintenance Manuals, including:

a) Operations manuals for system components.

b) Operations manuals for user interfaces and system program.

c) Contact information for 24 hour a day, 7 day a week, 365 day a year technical support hotline.

3) As-Built System Drawings, including:

a) Shop Drawings annotated to reflect installed condition of the system

1. Device Network ID's.

2. Room numbers for installed equipment and devices.

3. Feed circuit panel and breaker designations.

b) As-wired load schedules per panel reflecting zone, room, and group designations.

4. References
   a. Reference Standards
      1. Listing and Labeling: Where applicable standard have been established, 2. equipment shall be “Listed and Labeled” by a “Nationally Recognized Testing Laboratory” (NRTL) as defined in OSHA Regulation 1910.7. The terms “Listed and Labeled” shall be defined as they are in the National Electrical Code, Article 100.
      2. NEC Compliance: National Electrical Code (NFPA 70)
      3. NEMA Compliance: National Electrical Manufacturer’s Association
      4. Materials: All materials used in this project shall be new, unused and of the latest design. Re-furbished and obsolete materials are not permitted.
   b. Fabrication:
      1. The mechanical fabrication and workmanship shall incorporate best practices for good fit and finish. There shall be no burrs or sharp edges to cause a hazard nor there be any sharp corners accessible to personnel.
      2. All moving parts shall have specified tolerances. All equipment shall be built and installed to facilitate future maintenance and replacement.
   c. Finishes:
      1. Paint shall be the manufacturer’s standard finish and color except as noted.

B. Part 2 – Products
   1. Manufacturer’s
      a. Acceptable Manufacturer’s: Include dimming, switching, and control equipment as specified. This Specification is based upon products from Crestron Electronics, Inc. Equipment shall be as manufactured by Crestron Electronics Inc., Philips Controls, Lutron, or equal.
      b. Single Manufacturer: Provide system hardware with one common manufacturer. In order to establish single manufacturer responsibility, no integration of more than one manufacturer's hardware shall be allowed unless otherwise clearly noted in this Specification.
      c. Basis of Design Products: The following products establish the basis of design for the quality and function of the equipment and systems specified herein.
         1. GLE Series Commercial Dimming Panel
         2. C2N Series Keypads
         3. PAC2M Series Lighting Processor and Interfaces – Web based control capabilities
         4. TPS Series Touchpanel
      d. Substitutions:
         1. Applications for approval of alternate manufacturer’s shall contain, at a minimum, the following information:
            a) Evidence of compliance with Manufacturer

Qualifications as outlined below.

b) A listing of three (3) equivalent installations including:

1) Name, address and telephone number of Owner

2) Name, address and telephone number of Architect

3) Scope of work

c) Full system riser diagram(s) illustrating interconnection of system components, wiring requirements, back box sizes and any special installation considerations. Drawings shall include load and feed wiring as well as control wiring.

d) A detailed statement indicating paragraph by paragraph and line by line wherein the equipment submitted deviates from the Specifications.

e) A narrative confirming specified function and detailing alternate means for achieving specified function.

2. Approval to bid does not guarantee acceptance:

a) It shall be the responsibility of the Contractor to ensure that equipment and b) systems provided meet the requirements of this Specification.

b) Modifications to other equipment, systems, and infrastructure mandated by the use of alternate manufacturer's, equipment, and systems shall be the sole responsibility of the Contractor.

e. Manufacturer Qualifications:

1. Experience: The manufacturer shall have a minimum of ten (10) years of experience in the manufacture, programming, and support of Lighting Control Systems of similar size and scope.

2. Phone Support: The Manufacturer shall maintain a dedicated 24 hour a day, 7 day a week, 365 day a year toll free technical support hotline for life of the product.

a) Calls to this hotline shall be answered by a live support specialist.

b) Paging and call back systems shall not be an acceptable means of meeting this requirement.

3. Online Support: Installation and operations manuals for all standard products shall be available for download at no charge from the Manufacturer's website.

4. Field Support: The manufacturer must maintain on staff field service technicians for the purpose of programming, commissioning, repairing, and supporting control systems.

5. Environmental: Manufacturer shall be RoHS compliant in manufacture of all products provided and a member of USGBC.

f. Quality Control:

1. Wiring: Manufacturer shall assemble all dimming modules into dimming cabinets and complete all internal wiring at the factory prior to shipment. Wiring shall be 100% factory tested prior to shipment.
2. Testing: System testing shall be done as a complete, powered system.
   a) All dimmers shall be simultaneously connected to actual loads and all control stations shall be connected to the dimmer cabinet(s).
   b) The on-site testing and check out shall verify the system to be completely functional.

g. Delivery, Storage, and Handling:
1. Systems shall be ordered and released in compliance with manufacturer's instructions and stated lead-times to avoid construction delays.
2. Storage: Prior to installation, Contractor shall provide secure, dry, broom clean storage for all system components in an area or facility suitable for the storage of electronic devices.
3. Contractor shall install equipment only after the following conditions can be maintained in the area(s) where equipment is to be installed:
   a) Ambient temperature: 0° to 40° C (32° to 104° F).
   b) Relative humidity: Maximum 90 percent, non-condensing.
   c) Equipment must be protected from dust during installation
4. Control Surfaces (preset controllers, touch panels and keypads) shall only be installed once the installation area is a "conditioned space", as determined by the conditions outlined above and the following additional considerations:
   a) Heating/ cooling and humidity control systems are on line.
   b) All cutting, patching, painting, and sanding work is complete.

2. Dimming Cabinets – GLE Series
a. Mechanical
1. Dimming cabinets shall be factory assembled, wired and 100% tested prior to shipping from factory. The contractor shall be required to provide input feed wiring, load wiring, control wiring and all terminations or connections. No other wiring or assembly by the contractor shall be permitted.
2. Panels shall be passively cooled via free-convection, unaided by fans. Systems that are fan dependent or fan assisted for cooling of components are not acceptable. Systems that require or recommend regularly scheduled maintenance for air filtration components are not acceptable.
3. All input feed, load and control terminals shall be front accessible without the need to remove dimmer

assemblies or other components.

4. For Mains Fed Cabinets, Branch breakers with optional main breaker shall be provided above dimming modules mounted into the cabinet. For 120 volt cabinets the circuit breaker panelboards shall be Square D NQOD series with QOB series circuit breakers supplied or equal as manufactured by General Electric, or Siemens. For 277 volt cabinets the circuit breaker panelboards shall be Square D NF series with EDB series circuit breakers or equal as manufactured by General Electric, or Siemens, capable of up to 65,000 AIC ratings. Feed through panels shall also be available.
5. Panels shall be UL listed, CSA certified, NOM approved or CE marked (as appropriate).
6. Panels shall be shipped with each dimmer in a mechanical BYPASS position via a jumper bar inserted between the input and load terminals to allow dimming panel to be used as a temporary lighting panel with no possibility of dimmer failure due to short-circuit condition.
   a) These jumpers shall carry the full-rated load current and shall be reusable at any time.
   b) Mechanical bypass device must allow for switching operation of connected load with the dimmer removed via a circuit breaker.

b. Electrical
1. Dimming control cabinet(s) shall contain all dimming modules, control wiring, relays, contactors, power supplies and circuit breakers.
2. Branch circuit breakers shall be rated at 10,000 AIC unless otherwise noted and be thermal-magnetic in construction for overload and short-circuit protection. Circuit breaker panels included shall accept frame size breakers up to 65,000 AIC.
3. Dimming control cabinets shall be capable of being operated from a normal feed, an emergency feed or a normal/ emergency feed.
4. Normal / Emergency dimming control cabinets shall be fed by a single Normal / Emergency feed through the use of a line side (upstream) normal / emergency power transfer switch.

c. Dimming Modules
1. Dimming modules shall be compatible with the load types that are to be controlled. Each module shall be able to control a minimum of 6 separate circuits – each independently controllable and fed from their own circuit breaker.
2. Dimming modules for incandescent, magnetic low-voltage, two wire fluorescent, and neon / cold cathode loads shall have 6 channels each of which is controlled by dual back-to-back SCR's (silicon controlled rectifiers) rated at 40 amps. The modules shall have a minimum of 400 microsecond rise times from 10 to 90% of output waveform at maximum load. The SCRs shall be optically

isolated from the control circuit with at least 4000V RMS isolation. The SCR shall withstand transient voltages of 600 volts and surge currents of 625 amps for one full cycle. They shall also have a thermal conductive epoxy-potted toroid inductor for each channel to minimize lamp filament buzz and EMI/RFI emissions.

3. Dimming modules for 0-10V fluorescent dimming ballasted fixtures shall have 4 independent circuits using a an analog 0-10 VDC signal plus an air-gap relay and an LED indicator confirming 24 VDC power supply from Cresnet network.
4. Dimming modules for 3 wire dimming ballasts shall have 4 independently controlled circuits fed from the same phase of the power supply using a phase controlled dimming signal plus an air gap relay.

d. Normal / Emergency Panels

1. Panel shall be capable of operating from a normal feed, an emergency feed, or a normal/emergency feed. Panels requiring additional devices to make them capable of accepting normal/emergency or emergency feeds are not acceptable.
2. Upon the loss of normal input power, a panel operating from a normal/emergency feed shall immediately turn all circuits within that panel to full-on condition when emergency input power is present.
3. During the presence of normal power, circuits designated as emergency circuits shall be controlled via the same controls as circuits designated normal. If both normal and emergency circuits are on the same zone of control, all circuits shall react identically to a control intensity change.
4. Emergency power feed will be provided by an emergency generator. The generator must be capable of operating under no load conditions.
5. Normal / Emergency panels shall be fed by a single Normal / Emergency feed through the use of a line side (upstream) normal/emergency power transfer switch.
6. Under Emergency input power feed, unless otherwise indicated all dimmers shall operate at 100% of dimmer output voltage. Under these conditions, semiconductor device will be in the full-on state.
7. Under Emergency input power feed, if required, dimmer shall be capable of operating lighting load at an emergency level lower than 100% dimmer output voltage.
8. Under Emergency input power feed, all local control stations shall be inoperable. Once normal power is restored, all lighting zones shall revert back to their status prior to the emergency condition without requiring any action on the part of the user. Restoration to OFF, ON, or a "default" level is not acceptable.
9. Illumination levels shall be field-programmable to meet Local Code requirements for Emergency power

conditions. Such options include, but are not limited to, providing a constant minimal light level for emergency circuits during normal operation or providing full function dimming under emergency power.

10. System shall be capable of directly interfacing with a voltage detection/sensing device for Emergency lighting. The 3-Phase detection/sensing device shall: be UL 924 listed as Emergency Lighting and Power Equipment, with one dry contact closure input (normally open). The normally open input requires a maintained dry contact closure to activate the Emergency modeA status indicator will indicate when these inputs are activated, and have a function test switch with status indicator to simulate a phase failure.

3. Lighting Control System Processor – PAC2M
   a. The control processor for the lighting control system shall be a Crestron PAC 2M Series control system with a Motorola ColdFire microprocessor with 4MB of Flash Memory, 32MB of SDRAM and 256KB of NVRAM with expandability options.
   b. Ethernet connectible with 10/100Base T, Static IP or DHCP/DNS, SSL Protection, auto negotiating, full/half duplex TCP/IP, UDP/IP, SMTP, built-in Web server and email client; supports Crestron e-control2 Xpanel and RoomView applications.
   c. Connections: minimum of 4 and up to 8 Digital input/output or analog input ports (referenced to GND)
      1. Digital input: rated for 0-24VDC; input impedance 20K ohms; logic threshold 1.24 VDC.
      2. Digital output: 250 mA sync from maximum 24VDC; catch diodes for use with “real world” loads.
      3. Analog input: Rated for 0-10VDC, protected to 24 VDC maximum; input impedance 20K ohms.
      4. Programmable 5V, 2K ohms pull-up resistor per pin.
   d. Computer ports: (1) DB9 female RS-232 computer console port shall be provided on the processor.
   e. Relay outputs: (4) normally open isolated relays rated 1A, 30V AC/DC with MOV arc suppression across contacts and (2) 8 pin 3.5mm detachable terminal blocks.
   f. Power supply: processor shall provide an internal power supply to power Cresnet devices connected to (32) 4-pin 3.5 mm detachable terminal blocks, representing (4) Cresnet ports (paralleled) for each of (8) segments, providing up to a maximum load of 50 watts (2 amps @ 24 Volts DC). With an increased capacity of 75 watts using an external power supply.
   g. Backup processor capability: the processor shall monitor itself through an internal “watchdog” circuit which is capable of transferring control of the complete system supported by that processor to a second backup processor in the event of inactivity signifying a failure.
4. Keypads and Control Panels - C2N Series
   a. Manufacturer shall provide pushbutton style keypads with engravable button caps with integral LED light pipe feedback indicators. Keypads shall be field customizable from two to six

switch configurations without replacing the switch.

b. Each keypad and control panel interface shall communicate to the control system over the Cresnet bus, providing a 4-wire bidirectional communication and 24V power for up to 252 devices connectable by Cresnet wire.

5. Touchpanels – TPS-4L

a. Touchpanels shall be manufactured by the same manufacturer as the rest of the lighting controls system.

b. The display shall be an active matrix color LCD screen in panels of ten inches diagonal or larger with edge lit fluorescent illumination and a minimum viewing angle of +/- 60 degrees on the horizontal and a minimum of +40/-55 degrees on the vertical axis.

c. Pushbuttons (if needed) shall be replaceable, engraveable and programmable.

d. Touchpanel design and programming shall be included in the base cost of the system as determined by the manufacturer, and based on the scope of the project. Additional changes and programming of the touchpanel shall be available for additional fees.

e. Programming: (define system control design intent for operation and interface requirements)

1. Touchpanel design and function with defined graphics
2. Ability to adjust scheduling of lighting events secured with password protection)
3. Ability to show graphic representation of room combine option where required
4. Ability to integrate with other Building systems to control AV sources, HVAC controls, display security video inputs, and other systems.

C. Part 3 – Execution

1. Installers

a. Qualifications: Installer shall be one who is experienced in performing the work of this Section and who has specialized in the installation of work similar to that required for this project, and licensed or certified by local authorities having jurisdiction as an approved installer.

2. Field Conditions:

a. All bidders shall fully inform themselves of the conditions under which the work is to be performed.

b. No additional compensation shall be allowed for any labor or item the bidder could have been fully informed of prior to the bid date.

3. Commissioning

a. The Manufacturer shall provide the services of a qualified factory-employed field service engineer for a minimum of one (1) pre-wire visit and inspection. During this visit, the engineer will review the following with the Contractor's designated foreman or representative:

1. Layout and requirements of low-voltage control wiring network.
2. Separation of line voltage and control wiring.

3. Equipment locations and installation, including:
   a) Dimming panels
   b) Control processors
   c) Control interfaces
4. Control wiring network labeling and termination.
5. Load/ Feed wiring connections and termination.
6. Required information for programming and commissioning, including “As-Built” load schedules.
7. Connections to other equipment and systems.

b. The Manufacturer shall provide the services of a qualified factory-employed field service engineer for a system check out and commissioning visit
   1. The Contractor shall forward a written request to the manufacturer for this visit no less than twenty-one (21) days prior to the requested commissioning date.
   2. Contractor shall request final check-out and commissioning following installation and termination of all feed, load, and control wiring as well as installation of all lighting fixtures and lamps,
   3. Contractor shall provide “As-Built” schedules for all dimming and switching panels to the Manufacturer with the commissioning request.
   4. Field service engineer shall, in coordination with the Contractor, shall complete and document the following during final check-out and commissioning of the system:
      a) Verification of the proper connection of Manufacturer’s equipment to feed, load, and control wiring.
      b) Energization and configuration of manufacturer’s equipment, including: dimming and switching panels, control processors, and control devices.
      c) Installation and testing of control software and program.
      d) Verification of proper system operation and response on a circuit by circuit, control by control basis.
      e) Verification of the proper operation of manufacturer’s interfaces to other equipment and systems.
      f) Obtain sign-off on system functions

c. The manufacturer shall provide (1) visit for the purpose of educating the Owner’s representative(s) on the capabilities, operation and maintenance of Lighting Control Systems as installed.

2.35 ATHLETIC (SPORTS) SITE LIGHTING

A. General

1. Summary
   a. Work covered by this section of the Specifications shall conform to the contract documents, engineering plans as well as State and Local Codes.

b. The purpose of these Specifications is to define the performance and design standards. The manufacturer / contractor shall supply lighting equipment to meet or exceed the standards set forth in these Specifications.

c. The Sports lighting will be for the following venues:
   1. Softball Field
   2. Soccer Field 1
   3. Soccer Field 2
   4. Baseball Field 1
   5. Baseball Field 2

d. The primary goals of this Sports lighting project are:
   1. Guaranteed Light Levels: Selection of appropriate light levels impact the safety of the players and the enjoyment of spectators. Therefore light levels are guaranteed to not drop below specified target values for a period of 25 years.
   2. Life-cycle Cost: In order to reduce the operating budget, the preferred lighting system shall be energy efficient and cost effective to operate. All maintenance costs shall be eliminated.
   3. Control and Monitoring: To allow for optimized use of labor resources and avoid unneeded operation of the facility, customer requires a remote on/off control system for the lighting system including all costs to monitor for 25 years. Fields should be proactively monitored to detect fixture outages over a 25-year life cycle. All communication costs shall be included in the bid.

e. Environmental Light Control: It is the primary goal of this project to minimize spill light and glare to the players, spectators and adjoining properties.

2. Lighting Performance

a. Performance Requirements**:** Playing surfaces shall be lit to an average target light level and uniformity as specified in the chart below. Lighting calculations shall be developed and field measurements taken on the grid spacing with the minimum number of grid points specified below. Average illumination level shall be measured in accordance with the IESNA LM-5-04. Light levels shall be guaranteed not to drop below desired target values from the first 100 hours of operation for the maximum warranty period of 25 years or 10,000 hours.

b. Mounting Heights: To ensure proper aiming angles for reduced glare and to provide better playability, refer to Drawings for minimum mounting heights. Higher mounting heights may be required based on photometric report and ability to ensure the top of the beam angle is a minimum of 10 degrees below horizontal.

c. Lighting Methodology: There are two methods that will be considered for calculation of the lighting designs for this project. The approved Lighting Method #1, automated timed power adjustments, as described below utilizes methodology that adjusts light levels through a series of programmed adjustments. The alternate Lighting Method #2, straight depreciation, as described below uses continuous lamp lumen depreciation which

is recovered by relamping and cleaning lenses of the luminaires. Both methods must be at or above target light values throughout the 25 years of the contract/warranty provided by the manufacturer. Scans shall reflect initial design lumens, end of life design lumens, recoverable light loss factor (RLLF), and the Coefficient Utilization (CU) for the design. A +/- 10% design/testing allowance is not acceptable.

1. Lighting Method #1: Automated Timed Power Adjustments:
   a. The lighting system shall use automated timed power adjustments to achieve a lumen maintenance control strategy as describe in the IESNA Lighting Handbook 10th Edition, Lighting Controls Section page 16-8: "Lumen maintenance involves adjusting lamp output over time to maintain constant light output as lamps age and dirt accumulation reduces luminaire output. With lumen maintenance control, either lamps are dimmed when new, or the lamp's current is increased as the system ages."
   b. Independent Test Report: If lamp replacement interval is greater than 3,000 hours, manufacturer shall supply an independent test report with applicable recoverable light loss factors. Manufacturers bidding an automated timed power adjustment system must provide an independent test report certifying the system meets the lumen maintenance control strategy above and verifying the field performance of the system for the duration of the useful life of the lamp based on lamp replacement hours. Report shall be signed by a licensed professional engineer with outdoor lighting experience. If report is not provided at least 10 days prior to bid opening, the manufacturer shall provide the initial and maintained designs called for in this Specification under Lighting Method #2: Alternate Manufacturers, see below.
   c. Project References: Manufacturers bidding any form of Automated Timed Power Adjustment light system must provide a minimum of 10 project references within the state of Massachusetts that have been completed within the last 12 months utilizing this exact technology. Manufacturer will include project name, project city, and if requested, contact name and contact phone number for each reference.

Area of Lighting	Average Target Light Levels	Maximum to Minimum Uniformity Ratio	Grid Points	Grid Spacing
Softball Field	Infield/Outfield- 50 footcandles	Infield- 2.0:1.0 Outfield- 2.5:1.0	Infield- 25 Outfield- 84	20’ x 20’
Soccers Field 1-2	50 footcandles	2.0:1.0	77	30’ x 30’
Baseball Field 1-2	Infield/Outfield- 50 footcandles	Infield- 2.0:1.0 Outfield- 2.5:1.0	Infields- 25 Outfields- 103	30’ x 30’

2. Lighting Method #2 – Straight Depreciation

a. Light Level Requirements: Manufacturer shall provide computer models and guarantee target light levels on the field over 25 years. The specified maximum Recoverable Light Loss Factor of 0.65 and maintenance/group relamping schedule shall be provided in accordance with recommendations in the Leukos Abstract Volume 6, Number 3, January 2010, page 183-201: “Light Loss Factors for Sports Lighting”, and presented at the 2009 IESNA Annual Conference.

For Lighting Method #2, scans for both initial and target light levels are required.

1500w Fixture RLLF Requirements

Lamp Replacement Interval (hours)	Recoverable Light Loss Factor (RLLF)
3000	.65

b. Based on anticipated hours of usage (300 hours per year), Option #2 systems would require a minimum of 3 group lamp replacements over the 25 years. Data would reflect the actual RLLF adopted by the designer.

Area of Lighting	Average Initial Light Levels	Average Target Light Levels	Maximum to Minimum Uniformity Ratio	Grid Points	Grid Spacing
Softball Field	Infield/Outfield- 76.92 footcandles	Infield/Outfield- 50 footcandles	Infield- 2.0:1.0 Outfield- 2.5:1.0	Infield- 25 Outfield- 84	20’ x 20’
Soccer Fields 1-2	76.92 footcandles	50 footcandles	2.0:1.0	77	30’ x 30’
Baseball Field 1-2	Infield/Outfield- 76.92 footcandles	Infield/Outfield- 50 footcandles	Infields- 2.0:1.0 Outfields- 2.5:1.0	Infield- 25 Outfield- 103	30’ x 30’

c. Revised Electrical Distribution: Manufacturer shall provide revised electrical distribution plans to include changes to service entrance, panel, and wire sizing if exceed specified design loads.

3. Life Cycle Energy Costs
25 Year Life Energy Cost: Manufacturer shall submit 25-year life energy cost calculations as follows. If lamp replacement interval is greater than 3000 hours, manufacturer shall supply an independent test report with applicable recoverable light loss factors.
Lamp replacement schedule per charts below:

			Lighting Method 1	**Lighting Method 2**
a.	**Luminaire energy consumption** 162 luminaires x 1.56 kW demand per luminaire x .19 kWh rate x 300 annual usage hours x 25 years			
b.	**Demand charges, if applicable**	+		
	TOTAL 25 -Year Life Energy Operating Cost	=		

Lighting Method 1 Lamp Replacement	**1.3 Lighting Method 2 Lamp Replacement**
5,000 hour intervals	3,000 hour intervals

B. Product

1. Sports Lighting System Construction
   a. Manufacturing Requirements: All components shall be designed and manufactured as a system. All luminaires, wire harnesses, ballast and other enclosures shall be factory assembled, aimed, wired and tested.
   b. Durability: All exposed components shall be constructed of corrosion resistant material and/or coated to help prevent corrosion. All exposed carbon steel shall be hot dip galvanized per ASTM A123. All exposed aluminum shall be powder coated with high performance polyester or anodized. All exterior reflective inserts shall be anodized, coated, and protected from direct environmental exposure to prevent reflective degradation or corrosion. All exposed hardware and fasteners shall be stainless steel of 18-8 grade or better, passivated and coated with aluminum-based thermosetting epoxy resin for protection against corrosion and stress corrosion cracking. Structural fasteners may be carbon steel and galvanized meeting ASTM A153 and ISO/EN 1461 (for hot dipped galvanizing), or ASTM B695 (for mechanical galvanizing). All wiring shall be enclosed within the crossarms, pole, or electrical components enclosure.
   c. System Description: Lighting system shall consist of the following:

1. Galvanized steel poles and crossarm assembly.
2. Non-approved pole technology. Square static cast poles will not be accepted. Direct bury steel poles which utilize the extended portion of the steel shaft for their foundation will not be accepted due to potential for internal and external corrosive reaction to the soils and long term performance concerns.
3. Pre-stressed concrete base embedded in concrete backfill allowed to cure for 12-24 hours before pole stress is applied. Alternate may be an anchor bolt foundation designed such that the steel pole and any exposed steel portion of the foundation is located a minimum of 18 inches above final grade. The concrete for anchor bolt foundations shall be allowed to cure for a minimum of 28 days before the pole stress is applied.
4. All luminaires shall be constructed with a die-cast aluminum housing or external hail shroud to protect the luminaire reflector system.
5. Manufacturer will remote all ballasts and supporting electrical equipment in aluminum enclosures mounted approximately 10' above grade. The enclosures shall be touch-safe and include ballast, capacitor and fusing with indicator lights on fuses to notify when a fuse is to be replaced for each luminaire. Safety disconnect per circuit for each pole structure will be located in the enclosure. Integral ballast fixtures will not be accepted.
6. Wire harness complete with an abrasion protection sleeve, strain relief and plug-in connections for fast, trouble-free installation.
7. Controls and Monitoring Cabinet to provide on-off control and monitoring of the lighting system constructed of NEMA Type 4 aluminum. Communication method shall be provided by manufacturer. Cabinet shall contain custom configured contactor modules for 30, 60, and 100 amps, labeled to match field diagrams and electrical design. Manual Off-On-Auto selector switches shall be provided.
8. Lightning Protection: Manufacturer shall provide integrated lightning grounding via concrete encased electrode grounding system as defined by NFPA 780 and be UL Listed per UL 96 and UL 96A. If grounding is not integrated into the structure, the Manufacturer shall supply grounding electrodes, copper down conductors and exothermic weld kits. Electrodes and conductors shall be sized per NFPA 780. The grounding electrode shall be not less than 5/8 inch diameter and 8 feet long, with a minimum of 10 feet embedment. Grounding electrode shall be connected to the structure by a grounding electrode conductor with a minimum size of 2 AWG for poles with 75 feet mounting height or less, and 2/0 AWG for poles with more than 75 feet mounting height.
9. Safety: All system components shall be UL listed for the

appropriate application.

2. Electrical
   a. Electric Power Requirements for the Sports Lighting Equipment:
      1. Electric power: 480 Volt, 3 Phase
      2. Maximum total voltage drop: Voltage drop to the disconnect switch located on the poles shall not exceed three (3) percent of the rated voltage.
   b. Energy Consumption: The average kW consumption for the field lighting system shall be # kW for metal halide fixtures in Lighting Method 1. Lighting Method 2 kW will be defined in Life Cycle calculation chart (1.3) using a RLLF of .65.
   c. Revised Electrical Distribution: Manufacturer shall provide, at their cost, revised electrical distribution plans to include changes to service entrance, panel, and wire sizing if using Lighting Method 2.
3. Structural Parameters
   a. Mounting Heights: To ensure proper aiming angles for reduced glare and to provide better playability, the minimum pole mounting heights from the playing field surface shall be as noted above. Higher mounting heights may be required based on photometric performance of manufacturer's luminaires to meet spill and glare requirements.
   b. Support Structure Wind Load Strength: Poles and other support structures, brackets, arms, bases, anchorages and foundations shall be determined based on the IBC Building Code, wind speed of 110 mph, exposure category C. Luminaire, visor, and crossarm shall withstand 150mph winds and maintain luminaire aiming alignment.
   c. Structural Design: The stress analysis and safety factor of the poles shall conform to AASHTO, Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.
   d. Soil Conditions: The design criteria for these Specifications are based on soil design parameters as outlined in the geotechnical report. If a geotechnical report is not provided by the owner, the foundation design shall be based on soils that meet or exceed those of a Class 5 material as defined by IBC.
      It shall be the contractor's responsibility to notify the owner if soil conditions exist other than those on which the foundation design is based, or if the soil cannot be readily excavated. Contractor may issue a change order request / estimate for the owner's approval / payment for additional costs associated with:
      1. Providing engineered foundation embedment design by a registered engineer in the State of Massachusetts.
      2. Additional materials required to achieve alternate foundation.
      3. Excavation and removal of materials other than normal soils, such as rock and caliche.
   e. Foundation Drawings: Project specific foundation Drawings stamped by a registered engineer in the state where the project is located are required. The foundation Drawings must list the moment, shear (horizontal) force, and axial (vertical) force at

ground level for each pole. These Drawings must be submitted at time of bid to allow for accurate pricing.

4. Controls and Monitoring
   a. Remote Monitoring System: System shall monitor lighting performance and notify manufacturer if individual luminaire outage is detected so that appropriate maintenance can be scheduled. The manufacturer shall notify the owner of outages within 24 hours, or the next business day. The controller shall determine switch position (Manual or Auto) and contactor status (open or closed).
   b. Remote Lighting Control System: System shall allow owner and users with a security code to schedule on/off system operation via a web site, phone, fax or email up to ten years in advance. Manufacturer shall provide and maintain a two-way TCP/IP communication link. Trained staff shall be available 24/7 to provide scheduling support and assist with reporting needs.
      The owner may assign various security levels to schedulers by function and/or fields. This function must be flexible to allow a range of privileges such as full scheduling capabilities for all fields, to only having permission to execute “early off” commands by phone.
      Controller shall accept and store 7-day schedules, be protected against memory loss during power outages, and shall reboot once power is regained and execute any commands that would have occurred during outage.
   c. Management Tools: Manufacturer shall provide a web-based database and dashboard tool of actual field usage and provide reports by facility and user group. Dashboard shall also show current status of lamp outages, control operation and service scheduling including relamping operations completed and scheduled.
      Hours of Usage: Manufacturer shall provide a means of tracking actual hours of usage for the field lighting system that is readily accessible to the owner.
      1. Cumulative hours: shall be tracked to show the total hours used by the facility.
      2. Current lamp hours: shall be tracked separately to reflect the amount of hours on the current set of lamps being used, so relamping can be scheduled accurately.
   d. Communication Costs: Manufacturer shall include communication costs for operating the controls and monitoring system for a period of 25 years.

C. Execution

1. Field Quality Control
   a. Delivery Timing Equipment On-Site: The equipment must be on-site 4-6 weeks from receipt of approved submittals and receipt of complete order information.
   b. Illumination Measurements: Upon substantial completion of the project and in the presence of the Contractor, Project Engineer, Owner's Representative, and Manufacturer's Representative, illumination measurements shall be taken and verified. The illumination measurements shall be conducted in accordance with IESNA LM-5-04. For Lighting Method 1, Timed Power Adjustment systems, light levels must be measured and exceed the specified target levels. For Lighting

Method 2, light levels must be measured and meet the specified initial light levels.

c. Field Light Level Accountability
   1. Light levels are guaranteed not to fall below the target maintained light levels for the entire warrantee period of 25 Years.
   2. The contractor/manufacturer shall be responsible for an additional inspection one year from the date of commissioning of the lighting system and will utilize the owner's light meter in the presence of the owner.
   3. The contractor/manufacturer will be held responsible for any and all changes needed to bring these fields back to compliance for light levels and uniformities. Contractor/Manufacturer will be held responsible for any damage to the fields during these repairs.

d. Correcting Non-Conformance: If, in the opinion of the Owner or his appointed Representative, the actual performance levels including foot-candles, uniformity ratios, and maximum kilowatt consumptions are not in conformance with the requirements of the performance Specifications and submitted information, the manufacturer shall be liable to any or all of the following:
   1. Manufacturer shall at his expense provide and install any necessary additional fixtures to meet the minimum lighting standards. The Manufacturer shall also either replace the existing poles to meet the new wind load (EPA) requirements or verify by certification by a licensed structural engineer that the existing poles will withstand the additional wind load.
   2. Manufacturer shall minimize the Owner's additional long term fixture maintenance and energy consumption costs created by the additional fixtures by reimbursing the Owner the amount of $1,000.00 (one thousand dollars) for each additional fixture required.
   3. Manufacturer shall remove the entire unacceptable lighting system and install a new lighting system to meet the Specifications.

2. 25 Year Warranty
   a. Each manufacturer shall supply a signed warranty covering the entire system for 25 years or for the maximum hours of coverage based on the estimated annual usage, whichever occurs first. Warranty shall guarantee that the average light levels will not fall below target levels; lamp replacements; system energy consumption; monitoring, maintenance and control services, spill light control, and structural integrity. Manufacturer shall maintain specifically funded financial reserves to assure fulfillment of the warranty for the full term. Warranty may exclude fuses, storm damage, vandalism, abuse and unauthorized repairs or alterations.
   b. Preventative and Spot Maintenance: Manufacturer shall provide all preventative and spot maintenance, including parts and labor for 25 years from the date of equipment shipment. Individual lamp outages shall be repaired when the usage of any field is materially impacted. Owner agrees to check fuses in the event of a luminaire outage.

3. Pre-Bid Submittal Requirements
   a. Approved Product: Musco's Green Generation Lighting® Sports lighting system is the approved "Lighting Method 1" product. All submittal

information must be submitted at least 10 days prior to bid for any alternates using Method #1 or any manufacture using Method #2. An addendum will be issued prior to bid, listing any approved alternate lighting manufacturers and the design method to be used.

b. Design Approval: The owner / engineer will review pre-bid submittals as indicated above from all the manufacturers to ensure compliance to the Specification. If the design meets the design requirements of the Specifications, a letter and/or addendum will be issued to the manufacturer indicating approval for the specific design submitted.

c. Bidders are required to bid only products that have been approved by\ this Specification or addendum by the owner or owner's representative. Bids received that do not utilize an approved system/design, will be rejected.

2.36 MINERAL INSULATED METAL SHEATHED CABLE (MI CABLE)

A. Section Includes
1. Type MI mineral-insulated seamless metal sheathed cable.
2. Cable connectors and connections.

B. References
1. ANSI/NFPA 70 - National Electrical Code; UL 2196.

C. Submittals
1. Product Data: Provide for each cable assembly type.
2. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

D. Qualifications
1. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years documented experience and manufactured in North America.
2. Cable shall not off gas or propagate smoke.

E. Regulatory Requirements
1. Conform to requirements of ANSI/NFPA 70.
2. Furnish products listed and classified by Underwriters Laboratories, Inc. As suitable for purpose specified and shown.

F. Project Conditions
1. Verify that field measurements and conditions are as shown on Drawings.
2. Cable routing shown on Drawings is approximate unless fully dimensioned. Route cable to meet project conditions.
3. Where cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

G. Coordination
1. Coordinate work specified in this Section with work provided under other electrical work and the work of other trades.
2. Determine required separation between cable and other work.
3. Determine cable routing to avoid interference with other work.

H. Manufacturer's – Mineral-Insulated Metal-Sheathed Cable
   1. Tyco Thermal Controls/Pyrotenax System 1850 2-hour fire rated, or equal.

I. Mineral-Insulated Metal-Sheathed Cable
   1. Description: ANSI/NFPA 70, Type MI
   2. Conductor: Copper
   3. Insulation Voltage Rating: 600 volts.
   4. Cable Temperature Rating: 75 degrees C.
   5. Termination Temp. Rating: 90 degrees C.
   6. Insulation Material: Magnesium oxide refractory mineral.
   7. Metal-sheath Material: Seamless soft drawn copper.
   8. Fire Rating: Cable assembly including supports shall have a 2-hour fire rating as listed and classified by Underwriters Laboratories, Inc.
   9. Over jacket is available.

J. Wiring Connectors and Terminations
   1. Cable Termination:
      a. Tyco Thermal Controls/Pyrotenax Model Quick-Term Installation Sheet 638. (Solid M.I. conductor to approved solid rated lug is also available as a slight variation to the Quick-Term Termination.)

K. Examination
   1. Verify that cable end factory temporary seals have remained intact, that the insulation has not been exposed to air, and that no moisture has entered cable insulation.
   2. Verify that work of other trades likely to damage cable has been completed

L. Storage
   1. Cables shall be shipped from the manufacturer with ends temporarily sealed against moisture ingress.
   2. When cables are cut in the field, the end shall be sealed using standard sealing compound and PVC tape
   3. Cable shall be stored in a clean dry location.

M. Handling
   1. Cable shall be uncoiled by rolling or rotating supply reel. Do not pull from coil periphery or center
   2. Take precautions necessary to prevent damage to cable from contact with sharp objects, including pulling over foreign material or sheaves.

N. Wiring Methods
   1. Fire Rated Locations: Use only fire rated cable.
   2. Use wiring methods indicated on Drawings and as specified herein.

O. Installation
   1. Install products in accordance with manufacturer's instructions.
   2. Bending:
      a. Not less than five (5) times the cable diameter for cable not more than ¾ inch (250 kcmil).

b. Not less than ten (10) times the cable diameter for cable more than ¾ inches (350 and 500 kcmil).

3. Pulling:
   a. For all cables up to and including #1 AWG use 24 inch (250mm) or larger sheaves.
   b. For #1/0 through 250 kcmil inclusive, use 18 inch (460mm) or larger sheaves.
   c. For 350 kcmil and larger cables, use 24 inch (610mm) or larger sheaves.
   d. On pulls of over 360 degrees, contact manufacturer for assistance.
   e. 350 and 500 kcmil cables shall not be pulled more than 360 degrees in total.
4. Splicing: All fire rated splices shall be made in the factory.
   a. In the event a field splice is necessary, it must be approved by the engineer and made in field by personnel trained by cable manufacturer using manufacturer's components.
5. Terminations:
   a. Field made terminations shall be made with cable manufacturer's termination kits only. Stripping tools, crimping and compression tools available from the manufacturer shall be used for proper cable termination.
   b. Terminations must be completed immediately once started to avoid moisture ingress from surrounding air. Prior to completing each termination, test insulation resistance and follow manufacturer's drying procedures until insulation resistance reaches an acceptable level.
   c. Connections to ferrous cabinets for single conductor cables shall incorporate brass plates ¼ inch (6mm) thick by 4 inch (100mm) wide by proper length with ½ inch (12mm), ¾ inch (19mm), 1 inch (25mm) or 1-1/4 inch (32mm) drilled and tapped holes. Install per manufacturer's' Drawing.
   d. For applications using 90 degree C rating of cable, lugs shall be rated 90 degrees C.

6. Sheath Induction Reduction:
   a. When multi-phase circuits have paralleled single conductors, cables shall be run in groups having one of each phase in each group.
   b. Each set of paralleled conductors shall be separated by at least 2.15 single cable diameters.
   c. On balanced three-phase wye circuits neutral conductors may be located within the 2.15 cable diameter space between groups of phase conductors.
   d. Each group of cables shall be fastened tightly together, at least once between each cable support on horizontal runs and twice on vertical runs, using ½ inch (13mm) wide by 0.030 inch (0.75mm) thick stainless steel straps.
7. Exposed of Surface Installations:
   a. Cable may be secured directly to fire rated Building structure using an approved method such as one, or any combination, of the following:

1) Straps: ½ inch (13mm) wide x 3-1/2 inch (90mm) long by 0.030 (0.75mm) thick stainless steel or copper straps. Each strap shall contain two ¼ inch (6mm) holes for securing with 3/16 inch (5mm) by minimum 1-3/4 inch (44mm) long steel anchors.
2) Steel struts and cable tray: Use only the steel strut framing system and support recommended by Pyrotenax. Aluminum or other materials are not acceptable.
3) Other approved method.

b. Supports shall not exceed six (6) feet on center horizontally, or six (6) feet vertically.
c. Cables shall be installed parallel to Building lines.

8. Embedded Installations:
   a. Cables will be run in the same trifoil configuration as exposed installations.
   b. Protect against damage during pulling, and during concrete pouring or backfill and tamping.
   c. Where cables emerge from grade, provide PVC conduit, metal plate or angle iron. This protection shall minimally extend from 18 inches (460mm) below grade to 8 ft. (2.5m) above grade.
9. Wall or Floor Penetrations:
   a. Provide sleeve to protect cable and penetration opening during pulling.
   b. Provide approved fire stopping of all penetrations.
10. Neatly train and lace cable inside boxes, equipment, and panelboards.

P. Field Quality Control
1. Inspect cable for physical damage and proper connection.
2. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
3. Verify continuity of each conductor.
4. Prior to energizing cables, measure insulation resistance of each cable. Tabulate and submit for approval.

2.37 FANS (DESTRATIFICATION)

A. Provide as shown on the plans, non-power overloading ceiling mounted destratification fan(s). Fan(s) shall be of the specified size, arrangement and capacity. Fan(s) having tip velocities greater or requiring horsepower greater than those identified as the Project Standard will not be acceptable.

B. The fans shall bear the AMCA certified ratings seals for both air and sound performance. Fan ratings shall be based upon tests performed in strict accordance with AMCA Standard 210-67 test code for air moving devices. Each fan shall carry near the manufacturer's nameplate, the seal authorized by AMCA indicating that ratings are certified. Fans not bearing this seal will not be acceptable.

C. Each fan shall have tagging identification engraved on the manufacturer's nameplate. Units shall be manufactured by Leading Edge No. 5620-1, or equal as manufactured by Cook or Peerless.

D. Propeller Criteria:
1. Blades diameter shall be 56” and shall be constructed of die formed, aerodynamically contoured steel. Each blade shall have a high tensile steel bracket spot welded in a minimum three (3) point suspension formation, ground smooth following assembly. Bracket shall anchor its blade to the motor rotor assembly using a minimum of two (2) machine screws to support maintainability.
2. Blades shall be finished in epoxy enamel finish over electro-statically applied epoxy powder primer, color white. Blade sets shall be weight matched to within two (2) grams tolerance and shall be statically and dynamically balanced following the coating and assembly processes.
3. Fans to be installed less than ten feet (10’) above the floor shall have rolled edge blades a minimum of 3/16 inches in thickness in conformance with U.L. Standard 507.

E. Motor Criteria:
1. Each fan motor shall be sized to drive its fan. Whenever starting requirements exceed operating requirements, the motor shall be selected large enough to start the fan without overheating.
2. No motor shall operate within the service factor range.
3. Motor shall be of the heavy duty, fixed shaft-rotating housing type carefully matched to the fan load. Motor shall be premium efficiency, 0.91 minimum power factor, poly-phase or single phase as identified on the Drawings.
4. Motor shall be suitable for use with solid state motor speed controllers. Provide embedded automatic-reset type thermal overload protection. Fans to be so labeled in accordance with U.L. Standard 507.
5. Motor shaft shall be steel bar rod, cold-drawn, minimum 5/8 inches in diameter. Shaft shall incorporate the necessary holes to incorporate down-rod assembly mounting and secondary safety cable mounting simultaneously.

F. Bearings:
1. Bearings shall be of the self-aligning, heavy duty, permanently sealed and greased chrome steel ball type.
2. The bearings shall be of sufficient size and quality to have AFBMA B50 rated lives in excess of 100,000 hours at maximum cataloged fan operating conditions.

G. Motor rotor/housing assemblies shall be of formed steel construction, deep drawn to provide air space for motor heat dissipation. Housing shall be finished in epoxy enamel finish over electro-statically applied epoxy powder primer.

H. Down-rod Assembly:
1. Down-rod assembly shall consist of 3/4 inch nominal outer diameter steel pipe finished in epoxy enamel finish over electro-statically applied epoxy powder primer.
2. Upper shackle shall secure directly to the down-rod, shall consist of nominal 1/8 inch thick formed, plated steel, and shall be rubber bushed to provide a resilient floating suspension for the mounting hook.
3. Lower yoke shall secure directly to the down-rod and shall consist of nominal 1/8 inch thick formed, plated steel. Yoke shall provide primary

support directly to the motor shaft and shall provide space for the secondary support cabling.

I. Fan accessories shall include:
   1. Factory installed secondary support assembly connected to motor shaft with minimum six (6) feet of 1/8 inch 7x7 galvanized cable. Rated breaking strength shall be 920 lbs. minimum.
   2. Totally enclosing fan guard of twelve (minimum) spoke across bar construction:
      a. Radial Bars – 5 gauge.
      b. Circumferential Bars – 5 gauge on three (3) inch centers.
      c. Heavy duty 16 gauge mounting brackets shall secure the fan guard assembly directly to the fan down rod assembly. Provide a secondary support assembly connected to fan guard mounting brackets with minimum six (6) feet of 3/32 inch 7x7 galvanized cable. Rated breaking strength shall be 920 lbs. minimum.
   3. U.L. listed solid state motor speed controller shall incorporate infinite speed control with positive “Off” position. Controller shall incorporate 8 ampere rated (minimum triacs and solid copper wire toroidal choke-type RFI suppression circuitry.

2.38 OFF GRID SOLAR PANEL SYSTEM

A. Provide AIMS 720 watt Off Grid Solar Panel System #KIT-1K12120-B1 including following components:
   1. PICOGLF10W12V120V - 1000 watt pure sine inverter charger
   2. PV120POLY - six (6) 120 watt solar panels
   3. SCC60MPPT - 60 amp MPPT solar charge controller
   4. 6FM200H – two (2) - 200 ah deep cycle batteries
   5. PVF100FT10AWG - 100 foot PV wire for solar panel (female)
   6. PVM100FT10AWG - 100 foot PV wire for solar panel (male)
   7. CBL08FT6AWGC - 8 foot charge controller cable set
   8. CBL08FT6AWG - 8 foot 6WG cable (inverter cable)
   9. CBL02FT6AWG - 2 foot 6AWG cable set (battery cables)
   10. CBL01FT6AWGRED - 1 foot jumper for fuse kit
   11. ANL100KIT - 100 amp inline fuse kit
   12. PV-6X120RACK Solar Rack - Holds up to 6 - 120 watt panels. Rugged Aluminum - Solid mounting feet.

B. Wiring shall be provided as per manufacturer’s specifications.

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. All equipment mentioned in these Specifications or those on the Drawings shall be furnished new except where noted and completely installed and adjusted and left in a clean, safe and satisfactory condition, ready for operation and all supplies, appliances, and connections of every sort and description necessary to the operation of the equipment shall be furnished and installed to the satisfaction of the Architect and Owner.

B. The Owner will not be responsible for materials and equipment until they have been tested and accepted.

3.2 CLEANING, ADJUSTING AND TESTING

A. At the completion of the work, all parts of the installation shall be thoroughly cleaned. All devices, equipment, conduits, and fittings shall be completely cleaned of grease, metal cuttings, dirt which may have accumulated during construction, and protection covers. Any discoloration or damage to parts of the Building, its finish or furnishings due to failing to properly clean the electrical system shall be repaired by the Electrical Subcontractor without cost to the Owner.

B. The Electrical Subcontractor shall test all work and equipment as directed by the Architect and by Authorities Having Jurisdiction, furnish all equipment, necessary personnel and the electrical power.

C. The entire installation shall be tested for shorts, grounds and open circuits and all defects shall be corrected before acceptance of his work. All work shall be demonstrated to be in proper operating condition to the complete satisfaction of the Architect and Owner.

D. Coordinate all start up, operation and testing activities with the Project Manager, General Contractor and the Commissioning Agent per Specification Section 01 91 00.
   1. Contractors' tests shall be scheduled and documented in accordance with the commissioning requirements. Refer to Commissioning Specification, Section 01 91 00, for further details.
   2. System verification testing is part of the Commissioning Process. Verification testing shall be performed by the contractor and witnessed and documented by the Commissioning Agent. Refer to Commissioning Specification, Section 01 91 00, for system verification tests and commissioning requirements.

3.3 SLEEVES, INSERTS AND SUPPORTS

A. The Electrical Subcontractor shall lay out and install his work in advance of the pouring of concrete floors and walls.

B. Furnish and install all inserts, conduit hangers, anchors and steel supports necessary for the support and installation of all electrical equipment.

C. Where openings are required in walls and floors for the passing of raceways, ducts or busways, the Electrical Subcontractor shall furnish the General Contractor with the necessary information regarding dimensions and locations so that he may install suitable concrete stops to provide these openings. Such openings shall be by the General Contractor in such a manner so as not to interfere with the fireproof integrity of the Building.

D. The Electrical Subcontractor will be held responsible for the location of and maintaining in proper position, sleeves, inserts and anchor bolts supplied and/or set in place by him. In the event that failure to do so requires cutting and patching of finished work, such work shall be done at the Electrical Subcontractor's expense by the General Contractor.

3.4 EQUIPMENT CONNECTIONS

A. The Electrical Subcontractor shall provide all connections to all equipment requiring electrical service, including power cables, branch circuit extensions, fire alarm cables, motors, controllers, lighting fixtures and all other equipment and systems specified or shown on the Drawings.

3.5 MOTOR AND CONTROL WIRING

A. The Electrical Subcontractor shall provide all wiring, including conduit, wire, junction boxes, disconnecting switches, and overcurrent protection, to and between all motors, starters, control devices and related electrical equipment whether specified or shown under Division 26 00 00 or other Divisions, except where such items are factory wired as well as factory mounted on the driven equipment.

B. Unless otherwise specified, the Electrical Subcontractor shall mount and align all starters, control devices, safety switches, power factor correction capacitors and other related electrical equipment whether specified in this or other Divisions of this Specification, except where such items are factory mounted on the driven equipment. The Electrical Subcontractor shall determine the correct rotation of any equipment connected to a polyphase motor and connect motor for this rotation before equipment is started.

C. Unless otherwise specified, all wiring to motors, control equipment and related electrical equipment shall run in rigid conduit or EMT, with flexible metal conduit connections or liquid- tight flexible connections where specified elsewhere. Conduits shall be large enough to accommodate motor branch circuits and grounding conductors whether or not so indicated on Drawings. Wire sizes shall be as shown or to comply with the National Electrical Code.

3.6 HVAC WIRING

A. Wiring for low voltage temperature control equipment is included under Division 23.

3.7 CONCRETE WORK

A. The General Contractor shall provide concrete work for site lighting pole bases, but not for Athletic (Sports) Site Lighting bases which shall be provided by the Electrical Contractor.

B. The General Contractor shall provide duct and conduit envelopes and pads for electrical equipment. The General Contractor shall provide 4” concrete pads for all floor mounted electrical distribution equipment.

C. This Contractor shall furnish all equipment anchor bolts and shall be responsible for their proper installation and accurate location.

3.8 GROUNDING

A. Grounding methods shall be in accordance with the Massachusetts Electrical Code Article 250 and local utility company regulations.

B. Furnish and install from the main service switch to the street side of the water meter a stranded copper grounding conductor in rigid steel conduit. If the water service pipe is of material which is not electrically conductive, furnish and install approved copper plates or rods buried and grounded below grade, to which the main service grounding conductor shall be connected.

C. Connections to the water pipe shall be made by a suitable ground fitting or lug connection to a plugged tee.

D. The required equipment grounding conductors and straps shall be sized in compliance with National Electrical Code and shall be provided with green insulation equivalent to the insulation on the associated phase conductors.

E. Flexible metallic conduit equipment connections utilized in conjunction with branch circuits shall be provided with suitable green insulated grounding conductors connected to approved grounding terminals at each end of the flexible conduit.

F. The neutral conductor of all circuits shall have an identifying marking preferable a covering of white, readily distinguishable from the other conductors. This wire shall be unbroken from the distribution switch to the outlet.

G. Each Electrical expansion fitting shall be provided with a bonding jumper.

H. Ground metal frame of Building. Where metal of frame of Building can not be grounded, provide concrete encased electrode as per National Electrical Code.

3.9 CONDUIT WORK

A. All wiring shall be installed in heavy wall rigid steel unless otherwise noted below and run concealed except as indicated on the Drawings. Branch circuit wiring in hung ceilings, furred spaces or exposed may be installed in electrical metallic tubing. Panelboard feeders may be run in electrical metallic tubing except panelboard feeders run underground or in concrete slabs shall be in heavy wall rigid steel conduit as specified above or PVC. All exposed conduit in spaces indicated as mechanical rooms and where installed exposed below the 8' level elsewhere on the project shall be rigid steel conduit. Conduit extensions in metal partitions may be made with flexible metal conduit, with grounding conductor.

B. Connections to portable and permanently mounted motorized equipment and motors, as well as the equipment housing, shall be made with approved liquid tight flexible metal conduit. Flexible connections shall be a maximum of 18” long and with grounding conductor. Flexible connections shall be used prior to attachment to equipment housings.

D. Conduit ends shall be cut square, threaded and reamed to remove burrs and sharp edges. Field threads shall be of the same type and have the same effective length as factory cut threads. Excessive exposed threads will not be allowed. Turns, wherever required in exposed conduit runs shall be made by the use of factory-made bends, or field made bends. Condulets, or in the event of a multiplicity of conduits making the same turn, a steel junction box with a removable steel cover may be used. Offsets and bends for changes in elevation of exposed conduit runs shall be made at walls or beams and not in open spaces

between walls or beams. Conduits shall be routed so as not to interfere with the operation of maintenance of any equipment. The entire job shall be done in a neat and workmanlike manner. Steel supports or racks shall be galvanized steel channel and fittings, Unistrut, Kindorf, Husky Products Company, or equal.

D. All conduit work shall be carefully cleaned and dried inside before the installation of conductors. Wire shall not be pulled into conduit system until Building is completed. Plug conduit ends to exclude dust, moisture, plaster or mortar while Building is under construction. No lubricants or cleaning agents which might have a deleterious effects on conductor coverings shall be used for Drawing conductors into raceways.

E. Drawings, in relation to routing of conduits, are diagrammatic. The number and size of conduits and wire shall be furnished and installed as indicated by the Drawings. Conduits shall be routed in the field so as to be coordinated with the Building structure. Concealed conduit shall be as short and direct as possible. Exposed conduit shall be run in straight lines parallel to walls, beams and columns and with right angle bends and threaded conduit fittings. All conduit in concrete slabs shall be run above bottom steel reinforcing, below top reinforcing and column ties. Conduits passing through floors, walls and beams shall be of such size, number and in such locations so as not to impair the strength of the construction. At time of roughing conduits in concrete slab area, prior to pouring of slab, the Electrical Subcontractor shall consult the Structural Engineer for coordination and approval of size, spacing and method of conduit installation in slabs and walls, as well as penetration of such. Particular attention shall be given to the installation of conduits at grouped areas, such as panelboard, cabinet and pull box entrances.

F. All metal conduit buried in the earth or fill shall be coated with two coats of heavy asphalt paint over its entire length, including couplings.

G. Raceways in ceiling spaces shall be routed in such an approved manner as to eliminate or minimize the number of junction boxes required, but also shall be routed in an orderly and organized manner. Support rods and clamps shall be furnished and installed as directed by the Architect. Support of conduits by use of wire is strictly prohibited. Conduits shall be supported and secured by conduit support devices.

H. Where rigid metal conduit is threaded in the field, a standard conduit cutting die providing 3/4” taper per foot shall be employed. Threadless coupling shall not be used on rigid metal conduit except where specifically allowed by the Architect. Running threads shall not be used on rigid metal conduit.

I. Conduit work shall be installed in such a manner to keep exposed threads to an absolute minimum, and in no case shall more than three threads be left exposed after the conduit work is made up tight. This requirement applies to all conduit work, including conduit buried in earth or fill or in concrete.

J. Minimum size conduit shall be 1/2” nominal trade size.

K. A minimum 3/16” diameter twisted nylon plastic type fish cord shall be furnished and installed in all empty raceways. Provide a tag on each end of fish cord indicating the location of the other end.

3.10 WIRE AND CABLE

A. Wiring for all branch circuits and feeder circuits shall be color coded as follows:

1. 3-phase, 4-wire, 208Y/120 volts:

Phase	Color
A	Black
B	Red
C	Blue
Neutral	White
Equip. Ground	Green

2. 3-phase, 4-wire, 480Y/277 volts:

Phase	Color
A	Yellow
B	Brown
C	Orange
Neutral	Gray
Equip. Ground	Green

3. Connections to terminal shall be arranged Phase A, B and C from left to right.
4. Signal system shall be color coded differently from electrical systems described above.
5. For large size conductors available only in black, use colored plastic tape at all ends and where connections and splices are made for the specified color code identification. Tape shall be wrapped around the conductor three complete turns.

B. Branch circuits are in general arranged with one neutral conductor serving as “common” for 2 or 3-phase wires. In each case, the phase wires shall be connected to the phase supply mains in proper rotation to assure a balanced condition on the panel, or separate neutrals shall be used. The circuit numbers assigned on the Drawings are used for convenience only and need not designate the circuit on the panel to which that circuit may be connected. However, the circuit numbers and circuit description are required to be typewritten on the panelboard directory at the conclusion of the work, and shall represent the circuits as actually connected to the panelboard.

C. Joints and splices shall be made in an approved manner and shall be equivalent, electrically and mechanically, to the conductor insulation. Solid conductors shall be spliced with approved wiring connectors. Conductors of Size No. 8 AWG and larger shall be connected by use of solderless pressure connectors; these joints and splices shall be taped with one wrap of varnish cambric tape and then a minimum of three wraps of No. 88 Scotchbranch (3M Company) all-weather vinyl plastic electrical tape, or equal Permacel or Plymouth Company. Each wrap of tape shall be half-lapped. Conductors of Size No. 4 AWG or larger shall have two coats of insulating varnish applied over the tape.

D. Switch leg wiring shall be the same color as the phase conductor from which it is supplied.

3.11 INSTALLATION OF OUTLETS

A. If any discrepancy is found to exist between the electrical plans and any other Drawings associated with the project, notify the Architect at once and have location verified before outlets are installed. Any reasonable change in location of outlets and equipment prior to roughing shall not involve additional expense to the Owner.

B. Consult with the ceiling tile Subcontractor regarding the centering of outlets in ceiling tile.

C. Whenever outlets of any system are installed in brick, masonry or concrete construction, furnish and install the necessary boxes and conduit in connection therewith so that the General Contractor may build them in as the work progresses. Box offsets shall be made at all outlets to provide for proper adjustment to finished surfaces.

D. Through-wall boxes will not be permitted. Outlet boxes shall not be mounted back to back, but shall be staggered a minimum of 12” on center.

E. Knockouts in any boxes shall not be left open and all boxes not having equipment mounted on them shall be provided with blank covers.

F. Bar hanger type outlets shall be used in hollow framed partitions other than those of the masonry or construction block type, with bar hanger supported from two partition studs. Bar hangers shall be secured to metal type partition studs with self- threading metal screws, or drill through hangers with caddy (or equal) clips shall be used.

3.12 EXTERNAL TELEPHONE SERVICE

A. Furnish and install from utility pole to the Building, as shown on the Drawings, Schedule 40 PVC duct with pull wire for telephone cable installation. Consult with the Telephone Company regarding this service and do all work according to their requirements.

B. The Electrical Subcontractor will be responsible for providing complete telephone service to the Building. Coordinate number of lines required with the Owner prior to installation.

C. The Telephone Company will install the telephone cable to the Building. The Owner will pay for all backcharges incurred by the telephone company.

D. Provide pull strings for entire run of conduit for service cabling from telephone service origination to point of demarcation. Provide pull string for spare conduit.

3.13 EXTERNAL CABLE TV SERVICE

A. Furnish and install from utility pole to the Building, as shown on the Drawings, Schedule 40 PVC duct with pull wire for Cable TV service. Consult with the Cable TV Company regarding this service and do all work according to their requirements.

B. The Electrical Subcontractor will be responsible for providing complete Cable TV service to the Building.

C. The Cable TV Company will install the Cable TV cable to the Building. The Owner will pay for all backcharges incurred by the Cable TV company.

D. Provide pull strings for entire run of conduit for service cabling from Cable TV service origination to point of demarcation. Provide pull string for spare conduit.

3.14 ELECTRIC SERVICE

A. Consult with National Grid, hereinafter called the Utility Company, with respect to providing service and metering to the Building.

B. Primary Service:
1. The project shall be served from a utility company pole and shall run underground to a new pad mounted transformer.
2. Transformer shall be installed on a concrete pad where shown on the Drawings. The exact location for terminating primary and secondary conduit at the transformer shall be coordinated with the Utility Company. All 90° risers into transformer pad shall be rigid galvanized steel conduit.
3. The Utility Company shall furnish and install primary cable.
4. Transformer shall be furnished and installed by the Utility Company. Primary connections at the transformer shall be by the utility company.
5. The Electrical Subcontractor shall coordinate all work related to installing the primary services with the Utility Company. The Owner will pay for all backcharges incurred by the Utility Company.
6. The Electrical Subcontractor shall furnish and install an extra Schedule 40 PVC duct from the utility co. pole to the transformer pad as shown on the Drawings.

C. Secondary Service:
1. The Electrical Subcontractor shall furnish and install secondary conduit and cable from the pad mounted transformer to the main disconnecting device. Secondary connections at the transformer shall be by the Electrical Subcontractor. Terminal connectors at the transformers secondary service shall be furnished and installed by the Electrical Subcontractor. Secondary service characteristics shall be 480 volt, three phase, four wire.
2. The Electrical Subcontractor shall coordinate with the Utility Company to ensure the installation of the secondary service shall conform with the Utility Company's requirements.
3. Metering shall be provided at the transformer, by the Utility Company.

D. Division of responsibility with respect to the underground service extension shall be as follows:
1. The General Contractor shall be responsible for the work and materials required for the following:
   a. Excavation.
   b. Backfill.
   c. Transformer pad.
   d. Concrete encasement of conduit.
   e. Resurfacing of grades.

2. All other materials, equipment and labor required for the complete ductbank shall be furnished and installed by the Electrical Subcontractor under this Section, including the following:
   a. Primary and secondary raceways, including handholes.
   b. Grounding system.
   c. Pull strings.

3.15 UNDERGROUND DUCTBANK

A. Furnish and install ductbank as herein specified and as shown on the Drawings. The entire length of ductbank must be inspected and approved by the Utility Company prior to being covered.

B. Materials shall be as follows:
   1. Conduit-PVC Schedule 40.
   2. Conduit supports (duct system) shall be molded plastic with interlocking lugs and skeletonized structure. Minimum separation 3-1/2 inches.

C. Duct System shall be as follows:
   1. The size and number of conduit shall be as indicated on the Drawings.
   2. The entire length of ductbank shall be excavated and graded before any conduit is laid.
   3. The ductbank shall be set on undisturbed earth.
   4. The conduit shall be installed so that the top is a minimum of 36 inches below finished grade.
   5. Changes in direction shall be made by long sweep bends. Minimum radius 25 feet except that at the end of a run within 10 feet of termination, manufactured bends may be used having a minimum radius of 36”.
   6. Conduit base and intermediate spacers shall be installed a maximum of 5 feet on centers. Spacers shall not be placed one above the other but shall be staggered a minimum of 6”.
   7. All conduit joints shall be made watertight by means of a sealing compound before the coupling is installed. Joints in conduit shall be staggered. Minimum space between joints in adjacent conduit shall be 6”.
   8. When the required number of conduits have been installed, securely tie the assembly together at distances not exceeding 7 feet. Tie shall consist of three turns of No. 18 iron wire. Separate ties required for low tension and high tension conduit runs.
   9. Where conduit is encased, the duct envelope shall be of monolithic construction.
      a. Pouring of concrete shall be continuous throughout the length of construction. The end of the pour shall be interlocked or sloped. If the installation is halted, the ends of the conduit shall be plugged.
      b. Concrete shall not be poured until the conduit installation has been inspected and approved.
   10. After the installation is completed, each conduit shall be cleaned and identified. A standard flexible mandrel and stiff bristle brush shall be pulled through each conduit. The mandrel shall be not less than 12” long and the diameter approximately 1/4” less than the conduit.

11. Install approximately 12” below the top of the trench above each conduit or direct buried cable a 6-inch wide plastic warning tape. Tape shall be yellow in color with black letters reading “Buried Electric Lines.”
12. Electric handholes shall be precast and shall be installed where indicated. The exact location of each handhole shall be determined after careful consideration has been given to the location of other utilities, grading and paving. The location of each handhole shall be approved by the Architect before installation. Handholes shall be a minimum of 4'-0" by 4'-0" by 4'-0" high. Handholes shall be monolithically constructed precast-concrete having the required strength as established by ASTM A 79 Grade 60 and inside dimensions as indicated by the Drawings or Specifications. Frames and covers shall be delivered on the job unpainted and, after approval, shall be given two (2) coats of asphalt paint. In unpaved areas, the top of handhole covers shall be approximately 1-2 inch above the finished grade. Where existing grades that are higher than finished grades are encountered, provide a brick collar to elevate temporarily the handhole cover to existing grade level. Where duct lines enter handholes, the sections of duct may be either cast in the concrete or may enter the handhole through a square or rectangular opening of suitable dimensions provided in the handhole walls. Where openings are provided for the entrance of duct lines, the space between ducts and between ducts and handhole walls shall be caulked tight with lead wool installed over the handhole sump. A cable-pulling iron shall be installed in the wall opposite each duct line entrance. All handholes shall be provided with double-lockable type covers.

3.16 FIRE STOPPING

A. Electrical installations in hollow spaces, vertical shafts and ventilation or air handling ducts shall be so made that the possible spread of fire or products of combustion will not be substantially increased. Openings around electrical penetrations through fire-resistance rated walls, partitions, floors or ceilings shall be firestopped using approved methods to maintain the fire-resistance rating. Refer to Section 07 84 00 for Firestopping. All fire stopping material and installation will be by the General Contractor.

3.17 SPECIAL COORDINATION INSTRUCTIONS

A. Coordination with the work of other trades is referred to within various parts of this Section. The following special instructions shall also be carefully noted:
1. The Electrical Subcontractor shall obtain from the HVAC Engineer copies of all Shop Drawing prints showing the ductwork installation as it will be put in place on the project. These Drawings shall be thoroughly checked by the Electrical Subcontractor and the routing of all conduits and installation of all outlets and electrical equipment shall be coordinated with the ductwork so as to prevent any installation conflict. Such coordination shall be done prior to roughing-in conduits, outlets and electrical equipment.
2. Locations of all wall outlets shall be verified with the Architect prior to roughing in conduits. Refer to details and wall elevations on the Architectural Drawings; mounting heights indicated on these Architectural Drawings and/or specific dimensional information given to the Electrical Subcontractor by the Architect shall take precedence over

such information indicated on the Electrical Drawings.

3. Refer to all other Drawings associated with this project. Any equipment which requires an electrical supply circuit, switch, controls and connections, even though not indicated on the Electrical Drawings, shall be furnished and installed as directed by the Architect. Locations of lighting fixtures shall conform to the architectural reflected ceiling plans.
4. Refer to Architectural Drawings for areas in which the concrete slab is poured on grade. In these areas a moisture proofing membrane will be installed on the grade fill or earth prior to pouring of slab. Electrical conduits shall be so installed, where possible, to avoid the necessity of penetrating this moisture proofing membrane. Such penetration of the membrane shall only be made when specifically allowed by the Architect, and shall be made only at locations directed by the Architect.

3.18 ALTERNATES

A. Refer to Alternates, Section 01 23 00, for alternates affecting the scope of work under this Section.

B. The work of this Section, which is required by the scope of work as stated in the ALTERNATES, Section 01 23 00, shall comply with the applicable quality and performance requirements for similar work under this Section.

C. The Alternates which effect the Electrical Sections are:
1. Alternate No.1 – Wastewater Treatment Facility
   a. Alternate Number 1: All Electrical Systems related to the Wastewater Treatment Facility, labeled Alternate No. 1 in the Drawings and Specifications.
2. Alternate No. 2 – Storage, Support, and Restroom Facility
   a. Alternate Number 2: All Electrical Systems related to the Storage, Support, and Restroom Facility, labeled Alternate No. 2 in the Specifications and Drawings.
3. Alternate No. 3 – Synthetic Turf Football Field, Scoreboard, and Polyurethane Track
   a. Alternate Number 3: All Electrical Systems related to the Synthetic Turf Football Field, Scoreboard, and Polyurethane Track, labeled Alternate No. 3 in the Specifications and Drawings.
4. Alternate No. 5 – Athletic (Sports) Site Lighting
   a. Alternate Number 5: All Electrical Systems related to the Athletic (Sports) Site Lighting labeled as Alternate No. 5 in the Drawings and Specifications.

3.19 PROJECT CLOSEOUT

A. A certificate of completion shall be issued by the Electrical Subcontractor indicating that the installation is in conformance with the Construction Documents and all applicable Local, State and Federal Statutes and Codes. Final inspection by the Engineer shall be conducted after receipt of the Certificate of Completion. At minimum, life safety items shall be 100% complete including emergency lighting systems, the fire alarm system, and the emergency standby system before the Electrical Subcontractor request for final inspection. If final inspection

by the Engineer proves that the emergency lighting systems, the fire alarm system, and the emergency standby system are not 100% complete, the Engineer will backcharge the Electrical Subcontractor at his hourly rate for re-inspection.

END OF SECTION

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Section 26 00 01

ELECTRICAL FILED SUB-BID REQUIREMENTS
(FILED SUB-BID REQUIRED)

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. The BIDDING REQUIREMENTS, CONTRACT FORMS, and CONTRACT CONDITIONS as listed in the Table of Contents, and applicable parts of Division 1 - GENERAL REQUIREMENTS, shall be included in and made a part of this Section.

B. Work of this Section requires Filed Sub-bids and is governed by the provisions of the Massachusetts General Laws (MGL), Public Bidding Law - Chapter 149, Sections 44A to 44J inclusive, as amended, and applicable Sections of the MGL, Public Contract Law - Chapter 30.

C. Specification requirements for the Filed Sub-Bid "ELECTRICAL" include all of the following listed Specification Sections: in their entirety:

1. Section 26 00 01 - Electrical Filed Sub-Bid Requirements
2. Section 26 00 00 - Electrical
3. Section 27 10 00 - Structured Cabling
4. Section 27 21 33 - Data Communications Wireless Access Points
5. Section 27 40 00 - Audio-Video Communications
6. Section 27 50 00 - Distributed Communications and Monitoring
7. Section 27 70 00 - Video Distribution System
8. Section 28 13 00 - Access Control
9. Section 28 16 00 - Intrusion Detection
10. Section 28 23 00 - Video Surveillance

D. The work to be completed by the Filed Subcontractor for the work of this Section is shown on the following listed Drawings, not just those pertaining particularly to this Sub-Trade, unless specifically called out otherwise, regardless of where among the Drawings it appears:

E. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the Work of this Filed Subcontract.

1. Refer to Section 01 23 00 - ALTERNATES, for Bid alternates which may affect the scope of Work of this Section.

F. Sub-Bids for work under this Section shall be for the complete work and shall be filed in a sealed envelope with the Awarding Authority at a time and place as stipulated in INVITATION TO BID and INSTRUCTIONS TO BIDDERS.

1. The following shall appear on the upper left hand corner of the envelope:

NAME OF SUB-BIDDER: _____
SUB-BID FOR TRADE: ELECTRICAL.

2. Each sub-bid submittal for work under this Section shall be on forms furnished by Awarding Authority, as bound herein, accompanied with the required bid

deposit in compliance with MGL Chapter 149 Section 44B in the amount of 5 percent of Filed-Sub Bid.

G. Sub Sub-Bid Requirements: In accordance with Massachusetts General Law, Chapter 149, Section 44F, as amended, The Filed Sub-Bidder shall list in Paragraph E of the "Form for Sub-Bids" the name and bid price of each person, firm or corporation performing each class of work or part thereof for which the Section of the Specifications for that Sub-Trade require such listing.

1. This filed trade requires that the following classes of work be listed in paragraph E under the conditions indicated herein.

a.	Class Of Work	Reference Section
b.	Structured cabling	Section 27 10 00
c.	Data communications network equipment	Section 27 21 00
d.	Audio-video communications	Section 27 40 00
e.	Distributed communications and monitoring	Section 27 50 00
f.	Video Distribution System	Section 27 70 00
g.	Access control	Section 28 13 00
h.	Intrusion detection	Section 28 16 00
i.	Video surveillance	Section 28 23 00

1.2 EXAMINATION OF SITE AND DOCUMENTS

A. Bidders are expected to examine and to be thoroughly familiar with all contract documents and with the conditions under which work will be carried out. The Awarding Authority (Owner) will not be responsible for errors, omissions and/or charges for extra work arising from General Contractor's or Filed Subcontractor's failure to familiarize themselves with the Contract Documents or existing conditions. By submitting a bid, the Bidder agrees and warrants that he has had the opportunity to examine the site and the Contract Documents, that he is familiar with the conditions and requirements of both and where they require, in any part of the work a given result to be produced, that the Contract Documents are adequate and that he will produce the required results.

B. Pre-Bid Conference: Bidders are strongly encouraged to attend the Pre-Bid conference; refer to ADVERTISEMENT FOR BIDS for time and date.

1.3 SEQUENCING

A. Phasing: Refer to Section 01 10 00 - SUMMARY, and Drawings for phasing and milestone completion requirements which affect the General Contractor's Work and the Work of this Filed Sub-Bid.

B. Coordinate work of this Filed Subcontract with that of other trades, affecting or affected by this work, and cooperate with the other trades as is necessary to assure the steady progress of work.

C. Do not order or deliver any materials until all submittals, required in the listed Specification Sections included as part of this Filed Subcontract, have been received and approved by the Architect.

D. Before proceeding with installation work, inspect all project conditions and all work of other trades to assure that all such conditions and work are suitable to

satisfactorily receive the work of this Section and notify the Architect in writing of any which are not. Do not proceed further until corrective work has been completed or waived.

PART 2 - PRODUCTS

2.1 SCAFFOLDS AND STAGING

A. General: Filed Subcontractors shall obtain required permits for, and provide scaffolds, staging, and other similar raised platforms, required to access their Work as specified in Section 01 50 00 - TEMPORARY FACILITIES AND CONTROLS and herein.

1. Scaffolding and staging required for use by this Filed Subcontractor pursuant to requirements of Section 01 50 00 - TEMPORARY FACILITIES AND CONTROLS shall be furnished, erected, maintained in a safe condition, and dismantled when no longer required, by this Filed Sub-Trade requiring such scaffolding.
2. Each Filed Subcontractor is responsible to provide, maintain and remove at dismantling, all tarpaulins and similar protective measures necessary to cover scaffolding for inclement weather conditions other than those required to be provided, maintained and removed by the General Contractor pursuant to MGL (Refer to Section 01 50 00 - TEMPORARY FACILITIES AND CONTROLS and as additionally required for dust control).
3. Furnishing portable ladders and mobile platforms of all required heights, which may be necessary to perform the work of this trade, are the responsibility this Filed Subcontractor.

2.2 HOISTING MACHINERY AND EQUIPMENT

A. All hoisting equipment, rigging equipment, crane services and lift machinery required for the work by this Filed Subcontractor shall be furnished, installed, operated and maintained in safe conditions by this Filed Subcontractor, as referenced under Section 01 50 00 - TEMPORARY FACILITIES AND CONTROLS.

PART 3 - EXECUTION (Not Used)

End of Section

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Section 27 10 00

STRUCTURED CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of a Contract, including conditions of the Contract and Division 1 of the Specifications, shall apply to the Work in this Section.

B. Drawings and general provisions of the Contract, including all portions of the Project Manual are hereby made a part of this Section. Refer to paragraph titled “Quality Assurance” in this section and to Division 1 for requirements for Communications Subcontractors. Throughout this and related Sections, “Subcontractor” shall not be limited to the singular and masculine and shall refer to one, or more than one, Communications Subcontractor. The Terms “Communications Subcontractor” and “Communications System Integrator “shall be used interchangeably and shall be understood to represent the communications subcontractor responsible for the furnishing, configuring, testing, programming, warranting and ensuring all work is performed in accordance with manufacturer’s requirements and recommendations for the work identified in this SECTION.

C. Any qualifications or certificates required in this specification may be requested by the Architect as part of the post-bid qualifications review. Such review shall commence subsequent to the bid submission, as none of this information is required as part of the bid submission. In the event that the Architect requests qualification or certification documentation such documentation shall be provided within 3 business days.

1.2 SUMMARY

A. Work Included. The scope of work of this Section consists of the installation of all materials to be furnished under this SECTION, and without limiting the generality thereof, consists of providing all labor, materials, equipment, plant, transportation, appurtenances and services necessary and/or incidental to properly complete all cabling work as shown on the drawings, as described in the specifications, or as reasonable inferred from either or, in the opinion of the Owner, as being required and in general, is as follows:

1. Fiber Backbone and Fiber distribution cable for video, horizontal Cat 6A, 6 and 5e wiring, connecting devices, terminations, faceplates, patch panels, equipment racks with vertical cabling management and all related equipment, to complete installation, and testing of the systems to be used as signal pathways for voice, high-speed data, wireless access point cabling and CCTV transmission.
2. Copper Cat6A patch cords for every cabled port in the IDF closets and MDF.
3. Provide and install the following faceplates and jacks: WAP, OWAP, WAP4, WALL PHONE (PH), T1B, V8B, Data face plated (D#), A1 (A1 must have a blank port) A3 (must have 2 extra blank ports for video entry system cable pathway. Coordinate jack required for PA system admin phone with 27 50 00 communications subcontractor. Must be gray in color), A2, A4, F (fax lines), VB and CCTV (C###) (single gang faceplate with one RJ45 jack plus appropriate size patch cord (Cat6A) to CCTV cameras) and any other faceplate and jacks that are reasonably assumed to be primarily for data, wireless, CCTV or voice. CCTV cameras provided by 28 23 00. A1 (or any A faceplate with a PB designation near it) must have blank port for PB cable pass through (Coordinate with 28 13 00). For all floor box locations, provide and install appropriate mounting plates and jacks for floor box and poke through devices provided and installed by 260000.

Coordinate with 260000.

4. Nameplates, labels and tags for cables and faceplates. Coordinate with Owner.
5. Testing and Certification.
6. Label all Tel/Data conduits that terminate in a room on both ends (do not label stub ups from faceplates).
7. All above ceiling WAP, WAP4 and OWAP outlets shall be denoted on the ceiling tile below the outlet with a ½" green dot sticker.
8. All wall phone back boxes shall be a min of 6" away from any side wall, corner, door jamb or adjacent back box. Wall phone (PH symbol) faceplates shall be stainless steel.
9. Coordinate, provide and install all cabling as coordinated by each communications subcontractor (listed below) to complete the work in the following sections: 27 50 00 – Distributed Communications and Monitoring; 27 70 00 – Video Distribution System; 28 13 00 – Access Control, 28 16 00 Intrusion Detection, 28 23 00 Video Surveillance. All cabling shall comply with the respective sections manufacturer's requirements and shall not void any manufacturer's warranty.
10. Patch cords (blue for data, white for voice, Cat6A) connecting floor box data ports to furniture data jacks, where noted on drawings.

B. The work of this Section is shown on Technology Drawings numbers designated by a T.

C. No corridors or spaces are air plenums. No cabling needs to be plenum rated.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. All Sections of Division 27 and Division 28

B. SECTION 05 31 00 – STEEL DECKING See for restrictions concerning the hanging of material, cable tray, mounts, brackets, hooks, and other items from the roof or decking

C. SECTION 01 23 00 - ALTERNATES

D. The following related work or material shall be provided under the designated trades and under the listed SECTION:

1. Specialty Equipment: DIVISION 11, "EQUIPMENT"

2. Field Painting: DIVISION 9, "FINISHES"

3. SECTION 23 00 00- HVAC

4. SECTION 26 00 00 - ELECTRICAL

5. SECTION 22 00 00 - PLUMBING

6. SECTIONS of DIVISION 27 and 28

7. SECTION 12 68 00-SEAT AND TABLE ASSEMBLIES

8. SECTION 14 – ELEVATORS

E. Unless otherwise indicated, the following work is not included as part of the Communication Systems Integrator's responsibilities in this SECTION, except for coordination, and is to be performed by others as indicated:

1. Empty conduits for cable pathways to accessible point above finished ceiling or below floor shall be provided by the electrical subcontractor to ensure distance limitations of cables as determined by standards. Coordinate with RCDD of this section and notify architect of any discrepancies.

2. Cable tray, provided by the electrical subcontractor, shall be a black and a minimum of 20” wide by 6” high.

3. Floor boxes and poke through devices shall be provided by the electrical subcontractor.

4. Device boxes with plaster rings for data shall be provided and installed by the electrical subcontractor.

5. Clock system backboxes shall be installed by the electrical subcontractor and provided by the 27 50 00 Communications subcontractor.

6. Telephone system, installation and cross connections and devices provided by Owner contractor.

7. Speaker/paging system backboxes shall be installed by the electrical subcontractor and provided by the 27 50 00 Communications subcontractor.

8. Structural blocking to support wall and ceiling mounted equipment shall be provided by the General Contractor.

9. Computers and monitors and final connections to wall outlets shall be provided by the Owner.

10. Interface with public utilities telephone service shall be arranged and provided by the Owner.

11. Wide Area Network connections shall be arranged and provided by the Owner.

12. CATV service and connections to installed systems shall be arranged and provided by the Owner.

13. Electrical subcontractor shall provide access to interior of light poles for fiber to CCTV cameras and provide power for CCTV switch power supply. Coordinate access location and power required with 28 23 00 communications subcontractor.

F. The installation, operating cost and maintenance of the controlled environmental conditions, for equipment located on site by the manufacturer, NFPA 70B, or as specified in these specifications shall be the responsibility of the General Contractor.

1.4 SYSTEM DESCRIPTION

A. General: This system shall provide a cabling infrastructure system for voice and high speed data. Furnish and install complete systems consisting of patch / cross connection panels, single mode fiber-optic cabling, multimode fiber-optic cabling, multimode cabling to the digital signs, main distribution frame (MDF) racks (2 post relay rack type AND 4 post type, intermediate distribution frame (IDF) racks (non-server type, 2 post), TV suite racks (as shown on drawings, 4 post). Provide and terminate fiber-optic cabling as per the network riser detail drawing (T2.6) in all locations noted therein or as designated or inferred on the drawings. Provide appropriate amount of fiber termination ports in all areas to terminate all fiber. Provide all equipment as noted on the drawings or otherwise for a complete and

functioning system. Ensure all fiber counts are correct independent of the quantities shown on T2.6. Where discrepencies occur, provide the higher cable count. Higher fiber counts may be submitted if it is economical to do so, however all fiber shall be terminated unless noted otherwise. The horizontal 4 pair Category 6A copper cabling system shall be guaranteed to exceed all TIA-568-B.2-10 link and channel performance requirements and be capable of supporting 10G Base-T (802.3an) and ISO/IEC 11801 applications for a total distance of 100 meters with equipment cords. The system shall be guaranteed to meet all Cat6A requirements

B. This specification describes the desired form, function and performance of the backbone and horizontal cabling system. It is the responsibility of the installer of this section to design and provide a fully functional system in accordance with the intent and stated performance of this specification or better. Provide all communications wire, cable, fiber-optic cable, devices and related facilities installed complete as shown or as implied on the Contract Documents for fully functional systems, including, but not limited to:

1. Data, Voice, Fax, Wap and CCTV horizontal cabling and Fiber Backbone Cabling System, grounding and equipment including but not limited to:

   a. Fiber Optic Backbone Cabling
   b. Fiber Optic Cabling for Video
   c. Fiber Optic Connectors
   d. Fiber Optic Patch Cables. Provide patch cords for all fiber ports +10%
   e. Fiber Optic Patch Panels
   f. Equipment Racks
   g. Vertical Cable Managers
   h. Cabling Distribution Support
   i. Category 6A Data cabling (BLUE)
   j. Category 6A WAP (OWAP, WAP4) cabling (GREEN)
   k. Category 6A CCTV cabling (YELLOW)
   l. Category 6A Voice cabling (WHITE)
   m. Category 6A Fax line cabling (GRAY all fax lines homerun to MDF)
   n. Category 6A for any other requirements (GRAY)
   o. Category 6A RJ-45 Style Jacks (colored to correspond to the color of cabling)
   p. Category 6A angled Patch Panels
   q. Category 6A Patch Cables as specified below.
   r. Electrical subcontractor shall provide cable tray sized 6”H x 20”W min.
   s. Cabling Distribution Support (J hooks where no cable tray provided)
   t. Stainless Steel Wall Phone face plates
   u. 110 blocks mounted on plywood backboard and cross over cabling for fax lines.
   v. Grounding and bonding
   w. Ensure all cabling is protected from paint and paint overspray. Any cabling found with paint on the jacket shall be removed and replaced at no expense to the owner.
   x. Electrical subcontractor shall provide access to interior of light poles for data cabling to CCTV cameras. Coordinate access location and power required with 28 23 00 communications subcontractor.
   y. Horizontal 2RU cable manager below each patch panel stack
   z. All cabling shall be terminated in the IDFs or MDF as shown on the zone coverage drawings. Any deviations shall be brought to the attention of the architect.

aa. Provide and install two 2 inch conduit feed throughs from all sound closets to the accessible space above them for speaker and other cabling for the sound systems. Coordinate with 274000 communications subcontractor.

C. Work Not Included: The following work is not included in this section:

1. All computer workstations / printers and associated software (Provided by Owner)

2. Telephone system and instruments (Provided by Owner)

3. Public Address / Intercom System (Provided by 27 50 00)

4. Master clock system and secondary clocks (Provided by 27 50 00)

5. Video distribution system, TVs (Provided by 27 70 00)

6. Network electronics (Provided by Owner)

7. Wireless access point devices and controllers (Provided by 27 21 33).

D. Coordination: Coordinate device locations with furnishings and equipment.

1.5 REFERENCE SPECIFICATIONS, STANDARDS AND CODES

A. Comply with the referenced codes and standards and with the Contract Documents. Where conflicts occur, the more stringent shall apply.

B. Work shall meet or exceed the standards and procedures of the following:

1. ANSI/TIA/EIA 568-B.1 Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements.

2. ANSI/TIA/EIA 568-B.2, Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted-Pair Cabling Components

3. ANSI/TIA/EIA 568.2 Addendum 1, Transmission Performance Specification for 4-Pair 100 Ohm Category 6 cabling

4. ANSI/TIA/EIA 568.2 Addendum 10, Transmission Performance Specification for 4-Pair 100 Ohm Augmented Category 6 cabling

5. ANSI/TIA/EIA 568-B.3 Commercial Building Telecommunications Cabling Standard, Part 3: Optical Fiber Cabling Components Standard

6. ANSI/TIA/EIA 569-B Commercial Building Standards For Telecommunications Pathways And Spaces

7. TIA-568-C.0 Generic Telecommunications Cabling for Customer Premises

8. TIA-568-C.1 Commercial Building Telecommunications Cabling Standard

9. TIA-568-C.2 Balanced Twisted Pair Cabling Components

10. TIA-568-C.3 Optical Fiber Cabling Components Standard

11. ANSI/TIA/EIA 606-A The Administration Standard For The Telecommunications Infrastructure Of Commercial Building

12. ANSI/J-STD-607-A Commercial Building Grounding And Bonding Requirements For Telecommunications

13. ANSI/TIA/EIA-862 Building Automation Systems Cabling Standard for Commercial Buildings

14. ANSI/TIA-942 Telecommunications Infrastructure Standard for Data Centers

15. ASTM D 4566-05, Standard Test Methods for Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable, 2005

16. BICSI Telecommunications Distribution Methods Manual (TDMM) Current Edition

17. BICSI Information Transport Installation Manual (ITSM) Current Edition

18. ISO/IEC 11801 – Information Technology – Generic Cabling for Customer Premise

19. IEEE 802.3 Standard for Information technology -Telecommunications and information exchange between systems - Local and metropolitan area networks – Specific requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

20. IEC 61156-1, Multicore and Symmetrical Pair/Quad Cables for Digital Communications – Part 1: Generic Specification, 2005

21. NFPA-70 National Electrical Code 2008 edition

22. NECA/BICSI-568-A Standard for Installing Commercial Building Telecommunications Cabling

23. Federal Communications Commission Part 15 and Part 68

24. UL 444 – Standard for Safety of Communications Cable

25. UL 1666 – Standard for Safety of Flame Propagation Height

26. NFPA 262 – Flame Travel and Smoke of Wires and Cables.

27. BICSI Outside Plant Design Reference Manual, Current Edition

In the event of conflicts, the more stringent provisions shall apply.

1.6 COORDINATION

A. When articles, materials, operations or methods related to execution of telecommunications work are noted, specified, or described in the specifications or are indicated or reasonably implied on drawings and schedules, execute work as appropriate to provide complete and proper function, operation and installation.

B. The drawings utilize symbols and schematic diagrams to indicate items of work. These symbols and diagrams will not typically identify dimensions nor will they identify inclusion of specific accessories, appurtenances and related items necessary and appropriate for a complete and proper installation and operation. The Communications Subcontractor shall install work complete and ready for proper operation, including related items not specifically identified, shown, indicated or specified. The work shall be installed, in accordance with the intent diagrammatically expressed on the drawings, and in conformity with the dimensions indicated on architectural drawings and on shop drawings approved by the Communications System Integrator and Architect. When abbreviations appear on the drawings or specifications in upper or lower case letters, with or without periods, the resultant work shall be as stated above.

C. The drawings include details for various items, which are specific with regard to the dimensions and positioning of the work. These details are intended only for the purpose of establishing general feasibility. They do not obviate field coordination for the indicated work. Work shall not proceed until actual field conditions and requirements are verified by the Communications Subcontractor.

D. The drawings are diagrammatic and indicate the general arrangement of systems and equipment unless indicated otherwise by dimensions.

E. Where a PB symbol is present, provide a minimum of 1 blank port in the A faceplate at the PB location for PB wiring.

F. Coordinate with HVAC contractor the exact placement of ALL AC units, condensate and drain lines, to ensure NO AC unit is installed above ANY rack or plywood backboard in the MDF and all IDFs. No drain lines shall be routed above an equipment rack.

G. Coordinate elevator camera installation and card reader cabling with elevator contractor. Communications subcontractor of this section is responsible for all cabling and terminations of elevator CCTV camera installation except for traveller cabling. Elevator contractor is responsible for traveller cabling and connections to traveller cabling. Coordinate cabling requirements of elevator camera with 28 23 00 communications subcontractor. Equipment required for camera installation and connections to cabling (other than traveller cable) is the responsibility of the 28 23 00 communications subcontractor.

1.7 SUBMITTALS

A. General: Architect may require submittal submission within 45 days of bid award. Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections, Section 01300 and Section 26 00 00. Submittals shall be made as one complete package.

B. The Submittal shall include, but shall not be limited to the following:

1. Product Data for each component specified, including detailed manufacturer's specifications. Include data on features, ratings, and performance. Include dimensioned plan and elevation views of components. Provide an index and tabulated pages referencing the equipment in the specification. Any submittal received without a full index and tabulated pages shall be returned without action.

2. Provide qualification/certification data for firms and persons specified in the "Quality Assurance" article to demonstrate their capabilities and experience. Provide evidence of applicable registration or certification.

3. Field test and observation reports from qualified inspecting and testing personnel indicating and interpreting test results relative to compliance with performance requirements of the installed systems.

4. Final schedule of cables as specified in Part 3.

5. Shop drawings, prepared in AutoCAD, readable in AutoCAD Release 2010 or newer, detailing the cabling systems.

C. Shop drawing submittals shall include but shall not be limited to the following:

1. Construction plans indicating the following:

   a. Locations of all voice, data & audio/visual backbone cables with identification numbers.
   b. Location of termination racks and backboards.

2. System riser diagram indicating general arrangement of interconnections between system components on each floor of the building, identifying number and type of cables in each raceway.

3. Horizontal cabling, fiber, concentrator enclosures, MDF/IDF racks, and cross connect system. Include front-view details identifying all components, cabling connections, and cable identification numbers.

D. Cable Schedules: Prior to substantial completion, prepare and submit cable schedules for each of the communication systems installed under this section describing the as-built condition of the systems. Prepare cabling schedules in tabular form. Include the following information in each schedule:

1. Fiber Optic and Horizontal Cabling System Schedule:

   a. IDF/MDF room number
   b. Cable ID
   c. Origination Patch Panel & Port Number.
   d. Destination Room (old and new numbers if they change during construction)
   e. Destination Room faceplate location and jack number.

E. It is intended for the Submittal data to be complete and accurate at the first submission. If the submittal is returned marked "Resubmit" only one additional submission will be permitted. IF THE SECOND SUBMITTAL IS NOT ACCEPTABLE, OR IF THE SUBMITTAL IS NOT MADE WITHIN THE SPECIFIED TIME FRAME, THE RIGHT OF SUBSTITUTION AND SELECTION WILL BE LOST. THE OWNER WILL SELECT THE SPECIFIED ITEM. THAT ITEM IS TO BE PROVIDED AND SHALL BE PROVIDED AT NO ADDITIONAL COST.

F. A minimum period of 15 working days, exclusive of transmittal time, will be required in the Owner's office each time Shop Drawings, Product Data, layout drawings, catalog data and brochures are submitted or resubmitted for review. A minimum period of 20 working days exclusive of transmittal time will be required for reviewing substitute materials or

manufacturer. These time periods shall be considered when scheduling the work.

G. If proposed equipment deviates from the Specification or Drawings, indicate in writing on Company letterhead those differences and provide sufficient data to justify acceptance. FAILURE TO INDICATE DEVIATION OR SUBSTITUTIONS IMPLIES FULL COMPLIANCE WITH DRAWINGS AND SPECIFICATIONS.

1.8 RECORD DRAWINGS

Provide Record Drawings in accordance with Division 1 for requirements regarding Project Record Documents.

"As- Built" record documentation for telecommunications work shall include:

System function diagrams.
Communications flow diagrams.
Manufacturers' description literature for equipment.
Connection and programming schedules as appropriate.
Equipment material list including quantities.
Spare parts list with quantities.
Details not on original Contract Documents.
Test Results
Warranties
Release of Liens

Operation and Maintenance Manual:

Refer to Section 01 33 00 - Submittals for requirements pertaining to Operation and Maintenance Data.

The Communication System Integrator shall submit manuals in accordance with Division 1 containing manufacturers' brochures of items installed by the Communication System Integrator.

The manual shall be subdivided into separate sections with tab dividers to identify subsystems of the integrated system. Reference appropriate specification sections.

Provide the following additional information for each electronic system. Information shall be edited for this project where applicable.

Operations manuals for components and for system as a whole.

Maintenance manuals for components and for system as a whole.

Point-to-point diagrams, cabling diagrams, construction details and cable labeling details.

List of spare parts, materials and suppliers of components. Provide name, address and telephone number for each supplier.

Emergency instructions for operational and maintenance requirements.

Delivery time frame for replacement of component parts from suppliers.

Recommend inspection schedule and procedures for components and for system as a whole.

Complete “Reviewed” shop drawings and product data for components and system as a whole.

Troubleshooting procedures for each system and for each major system component.

Closeout Submittals:

1. As-Built Drawings: Update Shop Drawings to create final As-Built Drawings. Submit 3 copies digitally in AutoCAD 2010 or later format on a CD. Each faceplate shall show the faceplate port number and terminating servicing closet room number with patch panel letter and port number.

2. Maintenance Data: Include three (3) copies: maintenance and repair procedures.

3. Digital copies of all training materials and DVD videos of all training provided on CD and DVDs.

4. Warranty paperwork certified and provided by both the installer (installer/subcontractor warranty min 15 years) and the cable manufacturer warranty (min 15 years). Warranty certificates shall include contact numbers.

5. Submit costs for repairs and service not covered under warranty (ie: owner requested changes, acts of God, vandalism, misuse, etc).

6. PDF of product data and O&M manuals shall contain bookmarks for every section and item submitted.

1.9 QUALITY ASSURANCE

Equipment and materials required for installation under these specifications shall be the current model and new (less than one [1] year from date of manufacture), unused and without blemish or defect.

A. Installer Qualifications: Installer shall engage a registered communications distribution designer (RCDD) as part of the communications subcontractor team. Such RCDD can be an employee or consultant, but must be certified by the Building Industry Consulting Service International (BICSI). RCDD shall review the cable plant and bring any discrepencies to the attention of the architect. RCDD shall provide to Owner and Architect rack elevations for all racks in MDF and IDFs when actual cable plant is determined, to include UPS devices, patch panels (cat6A and fiber), CCTV system and NVRs, access control servers, phone equipment, intrusion system equipment, switching and wireless equipment and owner equipment. Coordinate equipment with contractors of the appropriate sections and owner. RCDD shall ensure no cable lengths are over distance limitations set forth in the standards, and shall bring any discrepancies to the attention of the architect. Coordinate actual rack placements in MDF and IDFs with architect and owner. RCDD shall review outdoor fiber plant design and bring any discrepancies to the attention of the architects.

B. Manufacturer Qualifications: Manufacturers shall be experienced in manufacturing components listed and labeled under TIA-568C.0, TIA-568C.1, TIA-568C.2, TIA 568C.3.

C. Comply with the following:

1. TIA-568C.0, Generic Telecommunications Cabling for Customer Premises

2. TIA-568C.1, Commercial Building Telecommunications Cabling Standard

3. TIA-568C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards

4. TIA-568C.3, Optical Fiber Cabling Components Standard

5. ANSI/TIA/EIA-526-7 Measurement of Optical Power Lossof Installed Single-Mode Fiber Cable Plant.

6. ANSI/TIA/EIA-14A Measurement of Optical Power Lossof Installed Multimode Fiber Cable Plant.

7. ANSI/TIA/EIA-569-A, Commercial Building Standard for Telecommunications Pathways and Spaces.

8. ANSI/TIA/EIA-606, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

9. ANSI/TIA/EIA-607, Commercial Building Grounding and Bonding Requirements for Telecommunications.

10. BISCI Telecommunications Distribution Methods Manual Standards, most recent volume.

D. All wiring must be run end to end with no splices (except for fiber, where splices are specified to be provided in certain locations). Terminated cables shall be punched down meeting approved methods. Any cables found to be spliced must be replaced at communications subcontractor's expense.

E. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

F. Work Coordination: Coordinate Work of this Section with owner's contractor for the telephone switch and telephone instruments, planned equipment, 27 40 00 communications subcontractor, wide area network (WAN) installed by Owner, 28 23 00 communications subcontractor for CCTV placements and the Technology Director of the School District.

1. Record agreements reached in meetings and distribute record to all participants in the meetings.

2. Adjust the arrangements and locations of distribution frames, patch panels, and cross connects in equipment rooms and wiring closets to accommodate and optimize the arrangement and space requirements of the telephone switch, LAN equipment, CATV Equipment and WAN equipment.

G. Communications subcontractor must be certified by the cabling manufacturer to install,

terminate and warrant cabling systems. Provide proof of manufacturers' certification for systems to be installed.

1.10 SUPPORT MATERIALS

A. Furnish support materials described below that match products installed, are packaged for storage, and are identified with labels clearly describing contents.

1. Cable: One 1000ft spool of Blue Cat6A used for Project.

2. Patch Panel Units: 2 angled 48 port of type used on project.

3. Connecting Blocks: 2 of each type 110 and 66.

4. Outlets Assemblies: 5 six port faceplates, and 10 blue cat6A jacks1 of each type used on the project.

1.11 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the communications subcontractor under other requirements of the Contract Documents.

B. Special Warranty: The data cabling system, including workstation outlets, cabling, connectors, patch panels and other connecting hardware, shall be warranted to be free from defects in material or faulty workmanship, and shall meet the performance requirements of TIA-568C.0, TIA-568C.1, TIA-568C.2, TIA 568C.3. The cabling system shall conform to the ANSI/TIAIEIA-568-B, specifications for any current or future application, which supports transmission over a properly constructed horizontal cabling system, which meets the channel, and/or basic link performance as described in TIA-568C.0, TIA-568C.1, TIA-568C.2, TIA 568C.3

C. The warranty shall cover material, services, and operation of the cabling system, end to end to include connectors/terminations, both copper and fiber. The warranty shall cover the operation of system to run minimum 1GB transmission on horizontal cabling category 6 systems, 10GB transmission on horizontal cabling category 6A systems, and 10GB on Multi-Mode Fiber backbone without exceeding the standard attenuation limit.

1. Special Warranty Period: 15 Year MINIMUM from date of acceptance. Provide warranty from Installer and manufacturer. Installer shall submit warranty tests to manufacturer on behalf of the owner and deliver the manufacturer warranty to the owner when complete.

D. The manufacturers of connectivity and cabling will certify installing communications subcontractor on the project to be warranted.

E. The communications subcontractor must be certified with the connectivity and structured cabling to be installed in the project that the communications subcontractor will be installing.

F. The communications subcontractor will supply a letter or other document that will detail the certification in regards to the connectivity and cabling systems installed to the Technology Services Department and/or Construction Manager prior to the final inspection and close of the project.

G. All test results and warrantees for connectivity and structured cabling shall be submitted to the Technology Director (Minimum two (2) copies of test results will be required in electronic format). Submittals must be received prior to substantial completion. Communications subcontractor is responsible for obtaining warranties for cabling. Provide ALL warranties the cabling system qualifies for.

H. Uncertified communications subcontractors will be required to remove structured cabling and pay for replacement by another certified communications subcontractor if the installation is not in compliance with certifying manufacturer or contract standards at no additional expense to the Owner.

J. Certifying manufacturers may be required to do inspections of cabling systems on project.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be suitably packaged by manufacturers to prevent damage during shipment and handling. Damaged materials will not be acceptable for use.

B. Store materials on site in clean, dry storage area.

1.13 ALTERNATES

A. Alternate 1 - New WWTF. All work related to the WWTF on drawing T2.6 shall not be included in the base bid, it shall be included in the ALTERNATE 1 bid. This work includes fiber and cat5 riser cabling.

B. Alternate 2 – Storage/Support/Restroom Facility. All related work on T2.4 and T2.6 for the facility shall not be included in the base bid. This work shall be included in the ALTERNATE 2 bid. This work includes associated rack, data, phone, CCTV, WAP4, fiber and cat5 riser cabling, terminations, and back boxes.

PART 2 - PRODUCTS

MATERIALS:

Manufactured Products:

Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.

When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer.

Equipment Assemblies and Components:

Components of an assembled unit need not be products of the same manufacturer, but must meet TIA/EIA Category 6A or 6, depending on cable type, criteria as a complete permanent link.

Manufacturers of equipment assemblies shall assume complete responsibility for the final assembled unit.

Components shall be compatible with each other and with the total assembly for the intended

service.

Moving parts or elements of equipment of the unit normally requiring lubrication shall have means provided for such lubrication and shall be adequately lubricated at the factory prior to delivery.

Factory cabling shall be identified on the equipment being furnished and on cabling diagrams.

Any equipment listed by manufacturer and/or model number is for performance criteria comparison only. In no way is it implied that the specific product must be provided. All equipment to be provided shall be 'or equal' unless noted as proprietary in the specification.

2.1 NETWORK BACKBONE CABLING

A. General:

1. The following types of backbone cables shall be used on this project:

   a. Single-Mode (SM) 9/125um fiber and OM4 Multimode 50/125um fiber cable for 10GB backbone distribution of data, voice, video, CCTV and video transmission backbone.

2. All Single-Mode and Multimode fiber for the backbone shall be terminated with LC style connectors.
3. See T2.6 and other technology drawing details for fiber types and strand counts
4. All fiber shall be run in appropriately sized innerduct. Riser-Gard by Carlon or equal by Maxcell or Pyramid for indoor fiber; Maxcell innerduct, with cells and size to fit applications for outdoor fiber or equal by Carlon or Pyramid.
5. Determine splicing locations, provide and install splices and equipment and all requirements to provide designed intent on T2.6 Network riser detail, T2.10 and T2.1 drawings. It is the responsibility of the communications subcontractor of this section to ensure a fully functional fiber plant (both single mode and multimode). Provide a loss budget analysis to make certain the system will function appropriately in accordance with standards over the proposed link. See owner for network electronics. RCDD shall approve loss budget analysis prior to work being performed. Forward copy of loss budget analysis to the architect.

B. OS2 Single-Mode Fiber-Optic Cable- SM 9/125um:

1. The fiber-optic cable shall be tightbuffer indoor/outdoor factory-fabricated, jacketed, low-loss, glass-type, fiber-optic single-mode, operating at 1310 nanometers (nm) and 1550nm.

   a. Strands Per Cable: as per drawing details. See T2.6 and T2.1
   b. The light guide building cable shall meet the following technical specifications:

      1. Fiber Dimensions: 9 micron core 250 micron coating 125 micron cladding 900 micron buffering
      2. Fiber Identification: Individually color-coded PVC buffer.
      3. Buffer Material: PVC
      4. Jacket Material: PVC
      5. Operating Temperature: -40 to 158. F

2. In cables with more than one fiber, the fibers shall be stranded around a dielectric

central member.

3. The cable and sub-unit jacket color shall be yellow for cables containing single-mode fibers, orange for multimode fibers. (Colored tape will not be used to re-identify jacket color).

4. The cable shall be all dielectric.

5. The individual fibers shall be color coded for identification. The optical fiber color-coding shall be in accordance with ANSI/TIA/EIA-598-A, “Optical Fiber Cable Color Coding.” The coloring material shall be stable over the temperature range of the cable, shall not be susceptible to migration, and shall not affect the transmission characteristics of the optical fibers. Color-coded buffered fibers shall not adhere to one another. The following color codes will be used:

   a. Blue.
   b. Orange.
   c. Green.
   d. Brown.
   e. Slate.
   f. White.
   g. Red
   h. Black.
   i. Yellow.
   j. Violet
   k. Rose
   l. Aqua

6. Jacket Printing: The outer cable jacket shall be marked with the manufacturer’s name or UL file number, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every two feet. The print color shall be black. The printing shall be permanent and legible for the life of the cable.

7. The fiber-optic cable shall meet the following standards:

   a. ISO 11801 2nd edition
   b. EN 50 173 2nd edition
   c. TIA-568C.3
   d. ANSI/TIA/EIA-492
   e. TELECORDIA GR-409
   f. ICEA S-83-596
   f. OFNR rated.
   g. NEC Section 770.

8. The optical fiber shall be single mode 9/125-micron fiber with the following characteristics:

   a. 1310nm: maximum attenuation, .80 dB/km

b. 1550nm: maximum attenuation, .50 dB/km

c. The attenuation of the cabled fiber shall be uniformly distributed throughout its length such that there are no discontinuities greater than 0.2 dB in any one-kilometer length of fiber.

9. The cable shall meet the following EIA cable tests:

a. Impact EIA-RS-455, FOTP-25

b. Compression EIA-RS-455, FOTP-41

c. Flexure EIA-RS-455, FOTP-104

d. Tensile Bending EIA-RS-455, FOTP-33

e. Temperature Bending EIA-RS-455, FOTP-37

f. Twist Testing EIA-RS-455, FOTP-85

g. Flame Test (OFNR) UL 1666 (NEC)

10. Packing and Shipping:

a. The cable shall be packaged in cartons and/or wound on spools or reels. Each package shall contain only one continuous length of cable. The cable packaging shall be constructed so as to prevent damage to the cable during shipping and handling.

b. Wooden reels shall be plainly marked to indicate the direction in which it would be rolled to prevent loosening of the cable on the reel.

11. The cable shall be Mohawk OS2 SM grade cable, of type appropriate for design intent or equal by Superior Essex or Corning. Outdoor grade fiber required for all exterior fiber runs.

C. OM4 Fiber-Optic cable MM 50/125um. Strands as per T2.6 and other technology drawing details.

1. The fiber-optic cable shall be factory-fabricated, jacketed, low-loss, glass-type, fiber-optic multi-mode, graded index, operating at 850 nanometers (nm), and 1300 nm.

a. Strands Per Cable: as shown on riser drawing T2.6.

b. The light guide building cable shall meet the following technical specifications:

1) Fiber Dimensions: 50 micron core 250 micron coating 125 micron cladding 900 micron buffering
2) Fiber Identification: Individually color-coded PVC buffer.
3) Buffer Material: PVC
4) Jacket Material: PVC
5) Operating Temperature: -40 to 158. F
6) Storage Temperature: -40 to 158. F

2. In cables with more than one fiber, the fibers shall be stranded around a dielectric central member.

3. The cable and sub-unit jacket color shall be orange for cables containing multi-mode fibers. (Colored tape will not be used to re-identify jacket color).

4. The cable shall be all dielectric.

5. The individual fibers shall be color coded for identification. The optical fiber color-coding shall be in accordance with ANSI/TIA/EIA-598-A, “Optical Fiber Cable Color Coding.” The coloring material shall be stable over the temperature range of the cable, shall not be susceptible to migration, and shall not affect the transmission characteristics of the optical fibers. Color-coded buffered fibers shall not adhere to one another. The following color codes will be used:

    a. Blue. .
    b. Orange.
    c. Green.
    d. Brown.
    e. Slate.
    f. White.
    g. Red
    h. Black.
    i. Yellow.
    j. Violet
    k. Rose
    l. Aqua

6. Jacket Printing: The outer cable jacket shall be marked with the manufacturer’s name or UL file number, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every two feet (e.g., “COMPANY — 01/94 — 50/125 MICRON — Type OFNR-(UL) 00001 FEET”). The print color shall be black. The printing shall be permanent and legible for the life of the cable.

7. The fiber-optic cable shall meet the following standards:

    a. ANSI-FDDI.
    b. ANSI/TIA/EIA-568-C.3-1 for 550 meter lenghts @ 10gb data rates.
    c. ANSI/TIA/EIA-526-14.
    d. ICEA S-83-S96.
    e. TR-NWT-000409.
    f. UL 1666.
    g. OFNR rated.
    h. NEC Section 770.
    i. ISO 11801

8. The optical fiber shall be multi mode 50/125-micron fiber with the following characteristics:

    a. 850nm: maximum attenuation, tight buffered, 3.5 dB/km Minimum Modal bandwidth, 500 Mhz.km. Loose tube max attenuation 3.0 dB/km.
    b. 1300nm:maximum attenuation, tight buffered, 1.25 dB/km Minimum Modal bandwidth, 500 MHz.km. Loose tube max attenuation 1.0 dB/km.
    c. The attenuation specification shall be a maximum attenuation for each fiber
    d. The attenuation of the cabled fiber shall be uniformly distributed throughout its length such that there are no discontinuities greater than 0.2 dB in any one-kilometer length of fiber.

9. The building cable shall meet the following EIA cable tests:

    a. Impact EIA-RS-455, FOTP-25
    b. Compression EIA-RS-455, FOTP-41

c. Flexure EIA-RS-455, FOTP-104
d. Tensile Bending EIA-RS-455, FOTP-33
e. Temperature Bending EIA-RS-455, FOTP-37
f. Twist Testing EIA-RS-455, FOTP-85
g. Flame Test (OFNR) UL 1666 (NEC)

10. Packing and Shipping:

    a. The cable shall be packaged in cartons and/or wound on spools or reels. Each package shall contain only one continuous length of cable. The cable packaging shall be constructed so as to prevent damage to the cable during shipping and handling.

    b. Wooden reels shall be plainly marked to indicate the direction in which it would be rolled to prevent loosening of the cable on the reel.

11. The cable shall be Mohawk grade 6 OM4 indoor riser distribution cable or equal by Superior Essex or Corning and Mohawk grade 6 OM4 outdoor grade loose tube or equal by Superior Essex or Corning, for all exterior applications (storage/support facility, press box, WWTFs, digital sign and any other outdoor locations requiring fiber).

D. Fiber Termination Hardware:

1. Provide/install/terminate all fiber provided as shown on the network riser drawings. All fiber shall be terminated with LC style terminations; different colors shall be used for SM and MM. The MM fiber to the digital sign shall be terminated at the sign with LC style connections, final connection shall be provided by the subcontractor responsible for the digital sign. Each fiber termination shelf shall include appropriate cable slack storage, labeling and strain relief. Provide wall mounted fiber termination cans near conduit entry point at each building fiber is called out as a destination that does not have a rack specified (both WWTF facilities, domestic water facility, fire pump house)

2. Fiber termination shelves shall be mounted at the top of the rack containing the electronic equipment.

3. Cable Connectors: LC-style connectors shall be used on ALL fiber. Polish: Flat PC; Termination procedure: pigtail splice (SM) or epoxy/polish (SM/MM). Insertion loss of connectors shall not be greater than .7dB

4. SM Fiber from V8 faceplates shall be terminated in TV Control room at top of rack.

5. MM fiber to the digital sign shall be routed as per T2.6 details.

6. Provide/install/test splices to provide design intent.

7. Some fiber and cable runs to outbuildings (storage/support facility, new wwtf, old wwtf, and press box) are in excess of 2500’-3000’
    a. Provide and install rack mounted fusion splice trays for multimode and single mode fiber in IDF 172. Label trays MM and SM. See T2.6 for splice details. IDF 172D shall be the collection point for cabling from the outbuildings serviced by 172D with cable originating in the MDF.
    b. Splice all fibers shown on T2.6 that enter and exit 172D except for the fiber (12 pair MM and 12 SM) that services IDF 172D.

2.2 FIBER PATCH PANELS

A. Fiber Optic Patch Panel and Rack Mount Enclosure

1. Patch panels shall have an anodized aluminum finish.

2. Patch panel shall have a clear cover on rear.

3. Patch panels shall be 6-Pack quad LC (24 fiber) type plates (as appropriate for the type of fiber being terminated) to terminate every strand of fiber in an enclosure no larger than 4U

4. Rack enclosure shall mount in a 19" equipment rack.

5. Rack enclosure shall have a front door with cable management and be constructed of durable polycarbonate plastic and black powder coated 16-gauge steel. Leviton Opt-X Ultra or equal by Corning or Hubbell.

2.3 FIBER TERMINATION DIGITAL SIGN

A. Fiber shall be terminated at the digital sign utilizing an NID 530 enclosure loaded with LC pigtails and LC duplex connectors.
1. Provide NID530 loaded with four (4) OM4 pigtails and two (2) LC duplex terminations. Include adapter and splice trays.
2. Leave 3rd pair of fiber dark and unterminated.
3. Provide FN530-CEKY by Leviton or equal at digital sign. Secure enclosure to inside of digital sign.

2.4 NETWORK HORIZONTAL CABLING

A. General:

1. The following types of data/signal cables shall be used on this project:

a. 4 pair Category 6A cable for distribution of Data signals. (Blue)
b. 4-pair Category 6A cable for distribution of Wireless Access Point signals. (Green)
c. 4-pair Category 6A cable for distribution of CCTV signals (Yellow)
d. 4-pair Category 6A cable for distribution of Voice signals (White)
e. 4-pair Category 6A cable for Fax lines (Gray)
f. 4-pair Category 6A cable for any other faceplate (Gray).

2. TERMINATION HARDWARE: The following types of connectors shall be used on this project:

a. Category 6A Jacks, BLUE, GREEN, WHITE, BLACK, YELLOW, RED, PURPLE.

B. Augmented Category 6 Cable DATA, VOICE, CCTV, WAP, and other faceplates as shown on drawings.

1. The Category 6A cable shall use the color code indicated below:

c. All Category 6A cable for Data, projectors and set top boxes shall be Blue.

d. All Category 6A cable for Voice shall be White
e. All category 6A cable for Fax lines shall be Gray.
f. All Category 6A cable for CCTV shall be Yellow.
g. All Category 6A cable for WAPs shall be Green.
h. Any other Category 6A required shall be Gray.
i. Colored tape may not be used to re-identify jacket color.

2. The cable shall be composed of 23-gauge bare solid copper conductors. Cable shall be insulated with a marked (every 2 ft) polyethylene vinyl chloride jacket. There shall be no shield required in the sheath.

3. Each sheath shall contain 4 unshielded copper twisted pairs. Each pair shall have a different twist ratio per foot ranging from 12 to 24 twists per foot.

4. The cable shall be sweep tested to 750MHz and operate up to 500MHz.

5. The cables shall meet or exceed the following standards:

a. IEEE 802.3an
b. ICEA 580-576.
c. Canadian Standards Association IWC FT4.
d. National Electric Code - Article 800.
e. Proposed ANSI X3T9.S requirements for UTP at 100 Mbps and 155 Mbs ATM.
f. Cable manufacturer must be ISO-9002 Certified.
g. TIA-568-C.2 CAT 6A
h. ISO/IEC 11801E2.1 CAT 6A
i. IEC 61156-5 CAT 6A Horizontal cable

6. In addition to complying with the above listed standards, all Augmented Category 6 cables shall meet or exceed the following criteria:

a. Testing shall be in accordance with procedures in the referenced standards unless otherwise stated.
b. All cables shall meet, as a minimum, the requirements of:

1. CSA
2. NEC
3. UL444
4. TIA-568-C.2 Category 6A
5. ISO/IEC 11801 Category 6

c. Factory splices of the insulated wire are not allowed in any portion of the cable, Butt-welded conductors prior to insulating are permitted.
d. Nominal OD: .295”
e. Conductor DCR: 6.6 ohm/100m MAX
f. DCR Unbalanced: 3% MAX
g. Mutual capacitance:46pF/m NOM
h. Capacitance unbalance pair/ground: 33pF/100m MAX
i. Characteristic impedance: 100 ohm +/- 7% (10-550MHz)
j. Prop delay: 534 +36/ fns/100m MAX

k. Prop delay skew: 45 ns/100m MAX
l. Nominal velocity of propagation: 68% non plenum, 72% plenum (f=frequency in MHz from 1-500)

The cable shall be GigaLan 10 Augmented Cat 6 by Mohawk or equal by Berk-Tek or Belden. Label cables as per direction for patch panel paragraph below.

2.5 TERMINATION HARDWARE

A. Modular 8 position modules:

1. Termination hardware shall be designed with an integral locking mechanism, which upon insertion of a modular plug provides maximum pullout strength at the plug/jack interface.

2. All modular 8-position jacks shall be RJ-45, T 568B wired.

3. The jacks shall meet or exceed the following standards:

   a. TIA/EIA-568-B.2-10 Transmission Performance Specifications for 4-pair 100 Ω Augmented Category 6 Cabling and the TIA-568C.2 Balanced Twisted Pair Cabling Standards

4. The modular jacks shall meet the following electrical performance and certification requirements:

   a. The modular jacks shall meet TIA/EIA-568-B.2-10 Transmission Performance Specifications for 4-pair 100 Ω Augmented Category 6 Cabling and the TIA-568C.2 Balanced Twisted Pair Cabling Standards
   b. Near End Crosstalk (NEXT) and Attenuation measurements shall be made per applicable TIA-568B.2 standards for Cat 6A.

5. The modular jacks shall meet the following requirements:

   a. Connector-insulation displacement connectors shall be capable of accepting 23 gauge AWG solid conductor wire.
   b. Terminated in accordance with EIA-568B specifications.
   c. Data/Wap/Voice/Fax jacks shall be RJ45.

6. The jack shall be approved to work in all applications up to 10 Gb/sec, including, but not limited to 1Gb/sec and 100 Mb/sec TP-PMD (100 meters over UTP, per ANSI X3T9.5), proposed 155 Mb/sec ATM, 16 Mb/sec token ring, 10 Base T and 4Mb/sec token ring.

7. The modular jacks shall use the color code indicated below:

   a. Data - Blue
   b. WAP - Green
   c. Voice – White
   d. Fax – Red

e. CCTV – Yellow
f. Set top boxes – Black (first data port on all T1 locations)
g. Bottom data port at VB plate: Purple. Top jack Blue.
h. Data at TV location, both jacks BLACK for Set Top Box.
i. Projector data in Auditorium booth purple, top left jack in D4 black, behind rack black for set top box.
j. Small Group projector jacks: One jack Purple one Blue. Top left jack in D4 at rack: black.
k. Projector data in Café, one Purple, One Black.

Category 6A jacks Leviton 6110g-RL6 or equal.

B. CCTV cable requirements

1. Install a single gang back box at CCTV locations (for exterior camera locations, mount box inside where conduit goes outside for exterior CCTV locations) with single port faceplate and Cat6a RJ45 yellow keystone jack. Secure box to the nearest building structure. Cat6A jack shall be yellow. Provide a 2' service loop of Cat6A at the single gang box. Provide 10' Cat6A yellow patch cord (or longer if box and camera location require it). All single gang boxes shall be hidden from view. All CCTV cabling shall be included in the Cat 6A cable tests.

C. D4 Data at CCTV Pole Bases

1. Provide and install at the base of every pole with cameras a 10"h x 8"w x 6"d NEMA 4x box with mounting back plate, stainless steel locking latch and pole mount. Electrical subcontractor shall connect the bottom of the NEMA box to the pole base using 1.5" conduit. Electrical subcontractor shall seal box and pole base. Do not seal inside conduit as 282300 will be using the conduit as a patch cord path to the cameras.
2. Provide and install 4 outdoor grade cat6 cables terminated in the storage and support facility IDF patch panels to the NEMA 4x box at the base of each pole that has cameras.
3. Terminate the four cat6 cables from the IDF at each pole inside the NEMA enclosure, in the lower right corner (other equipment is to be installed in the box by 282300), using a surface mounted single gang back box, faceplate and cat6 yellow keystone jacks. See T2.2 drawing.
4. Test each cable, ignoring distance limitations. Label all jacks as labeled elsewhere on the project.

2.6 PATCH PANELS

A. Category 6A- Data (included projector and set top box cabling), Wap, Voice and CCTV

1. All patch panels shall be Cat 6A angled 110 style patch panels, 24 or 48 port T568B wired, 2U maximum and all patch cords shall be routed directly into the vertical cable mangers. 6A587-U24 or 6A587-U48 by Leviton or equal.
2. Provide straight cat6a patch panel and horizontal 2RU cable management panel below patch panel in rack in TV head end room 4 post rack, for local TV suite data network cabling as noted on drawings. Use straight patch panels in swing racks in 118H and 271C if required to close the doors.
3. Patch panel ports connected to Black jacks shall be labeled S and have a color designation of black and shall have black patch cords provided. Projector data ports (all purple jacks), shall have the patch panel ports labeled P and have a purple color designation. Purple patch cords shall be provided for these ports.
4. Other ports shall be color labeled according to their cable color (green for wap, yellow for CCTV, white for voice, blue for data).

2.7 110 BLOCKS AND CROSS OVER CABLING

A. Provide and install on plywood backboard in MDF two (2) 110 wiring block with legs for fax line cross over cabling. Leviton 41aw2-100 with legs or equal by Hubbell or Siemon.

B. Terminate fax lines to 110 Blocks on plywood backboard. Cross connect phone line service provider's DEMARC for fax lines to 110 block and verify ALL fax lines as designated on the drawings function by testing fax capability of each phone line.

C. Fax lines shall be terminated with a single gang single port faceplate with red RJ45 keystone jack at the fax machine location.

2.8 CAT 5e MULTIPAIR CABLE

A. Provide non-plenum multi-pair Cat 5e cable from the MDF to each IDF and to each building as shown on the T2.6 drawing. Terminate both ends on 66 blocks with Amphenol connectors on the sides of the 66 blocks on plywood backboard in IDF and MDF, and between origination location and termination buildings as shown on T2.6. Mount 66 blocks near conduit entry point at each building called out as a destination that does not have a rack specified (both WWTF facilities, domestic water facility, fire pump house).

Cable is by Mohawk M58141 and M58522 in quantities required for cable counts shown on T2.6 or equal by Belden or Berk-Tek. Outdoor grade cable is required between all building locations.

B. Provide and install in IDF 172D 66 blocks to create a termination cross connection field on the plywood back board. See T2.6.

2.9 EQUIPMENT RACKS

A. Provide: All 2 post racks in MDF (provide and install), IDF racks (provide and install as shown on the drawings); shall be 7' tall, aluminum or steel floor-mounted and have mounting rails for standard 19" equipment. Provide racks as per technology drawing details. Provide and install at all two post racks (MDF, IDF, and other areas where a two post rack is shown on the drawings or as specified) uni-strut, threaded rod and other hardware required to secure the rack to the wall or building structure. Rack deflection shall not be more than 1" at top of rack.

B. All 2 post racks shall meet the ANSI/EIA 310-D standard and include the universal 5/8" hole pattern drilled on the front and rear.

C. All racks shall be properly grounded and bonded in accordance with ANSI/TIA/EIA-607, A minimum 6 AWG green conductors shall be used for grounding.

D. Provide vertical racks with horizontal (ladder type) cable trays (20" minimum) connecting all racks. A horizontal cable tray shall connect the telecommunications on the ¾" thick AC-grade or better fire-retardant plywood with at least two coats of flame retardant paint with the vertical racks.

E. Double-sided vertical cable management sections shall be provided for each 2 post rack. Vertical management sections may be integrated into the rack design or attached separately. Vertical management sections shall be provided for both sides of each individual rack. If more than one rack is installed in a row, a single vertical management section may be used to adjoin two racks. Eight (8) inch wide double-sided vertical cable management sections shall be provided for each side of each 2 post rack (Leviton 8980L-VFR or equal).

F. 4 post racks: provide 4 post racks in the MDF (as shown on the drawings, includes CCTV rack) and in the TV Head End and control room as shown on the drawings. Cooper B-Line open hole type with hardware kits (nutplates) or equal. DO NOT provide these 4 post racks for racks designated as “FOR OWNER SERVERS” (qty 3) on the drawing.

1. For racks designated as “FOR OWNER SERVERS” provide the following:
   a. Provide three (3) APC AR3150 Netshelter SX 42U with sides, black or equal
   b. Provide three (3) APC AR8442 vertical cable organizers, 8 cable rings, zero U or equal
   c. Provide three (3) APC AR7580 vertical cable managers for netshelter or equal
   d. Provide three (3) APC AR8172BLK data cable partitions or equal
   e. Provide one (1) APC AR7183BLK200 1U 19” black modular tooless airflow mgmt blanking panel – Qty 200 or equal
   f. Provide three (3) APC ACF201BLK rack side air distribution 2U 115v 60hz or equal
   g. Provide nine (9) AR8425A 1U horizontal cable manager or equal
   h. Provide six (6) AR8426A 2U cable managers or equal
   i. Provide six (6) AR8429 1U horizontal brush strip for front to rear cable or equal

2. All 4 post racks used in MDF (except the net shelters) and TV suite shall be 7’ tall, 29” deep aluminum or steel floor-mounted and have mounting rails for standard 19” equipment. Provide racks as per technology drawing details. Secure racks to floor in MDF. Do not secure racks to floor in TV suite.

4. All racks shall be properly grounded and bonded in accordance with ANSI/TIA/EIA-607. A minimum 6 AWG green conductor shall be used for grounding.

G. 27 70 00 communications subcontractor shall provide and install IPTV racks as designated on the drawings. Provide grounding and bonding for these racks. 27 50 00 communications subcontractor shall provide the PA cabinet/rack.

H. Provide floor standing swing out racks with recessed patch panels and rails (such that the cable terminations, patch cords and switches mounted inside allow the door to close and lock) in IDFs that show a 4 post rack against the wall (118H ,271C). Doors must be vented, close and be lockable. Middle Atlantic SR-40-28 with fan kit DWR-FK32 (cut fan kit to size) and vented front doors LVFD-40 (door must lock) or equal.

I. Provide Mid Atlantic ERK4425 rack with LVFD-44 vented lockable doors for the press box and Storage/Support/Restroom facility. Install patch panels and terminations at the top of the rack, such that 274000 can install sound system components at the bottom of the rack. Doors must close and lock. Provide moveable rails inside to recess all equipment to allow doors to close and lock with patch cables installed in patch panels. Leave a minimum of 2RU between the 271000 and 274000 equipment for the owner provided switch.

2.10 CABLE TRAY ACCESSORIES

A. Electrical subcontractor (26 00 00) to provide and install two (2) 120V 30 amp twist lock outlet NEMA type L5-30 to the bottom of the cable tray above each rack on drawings for the IDFs and MDF (except where noted that the rack outlets are to be wall mounted: TV control room and TV head end). Electrical subcontractor shall provide electrical service and twist lock plugs as appropriate as shown on the drawings. Electrical subcontractor shall provide 30 amp wall mounted twist lock outlets behind racks in the TV Control Room and TV Head end and anywhere else noted on the drawings. Provide two 208V 30 amp L-6 twist lock plugs above every rack to include net shelter racks; (do not provide 208v/30a at rack in TV control room or TV Head end, instead provide them on the wall behind the racks).

B. Electrical subcontractor (26 00 00) shall furnish and install “drop outs” where cabling drops out of cable tray above equipment racks and enters vertical wire management panels and at plywood backboards.

C. Electrical subcontractor (26 00 00) shall supply and install ladder rack from the equipment racks to the plywood backboard if cable tray is not shown on the drawings. Provide 20” wide ladder rack, by B-Line or equal with dropout section at plywood backboard.

2.15 Patch cords

A. Provide Cat-6A blue patch cords for every data port wired (except as identified below), Cat-6A green patch cords for every WAP port wired and Cat-6A yellow patch cords for every CCTV port wired and Cat-6A white patch cords for every voice port wired. Provide Cat-6A Black patch cords for every Black jack wired, and Purple Cat6A patch cords for the purple jacks wired. Provide these cables in lengths of 70% are 5’, 20% are 7’ and 10% are 10’ of the terminations. Provide 10% extra of each length and color.

B. Provide 10’ Gray Cat6 patch cord for VES port.

C. Provide patch cords for unused ports to owner.

D. Provide patch cords of appropriate length to connect floor data and voice ports to furniture data and voice ports as noted on the drawings. Cat6A, Blue for data, and Cat6A White for voice. Provide jacks and terminate in furniture as noted on the drawings.

PART 3 - EXECUTION

3.1 DISTRIBUTION OF CABLING WITHIN THE SCHOOL

A. Main Distribution Facility: The Main Distribution Facility (MDF) is a dedicated and secured room within the school that will host a major portion of the network equipment. Equipment racks shall be provided in the MDF, which shall support:

1. Wide area network (WAN) access equipment.

2. A majority of the local area network (LAN) equipment including the router, switching, and uninterruptible power systems (UPS).

3. Termination of fiber cabling from IDF(s) and other areas.

4. Termination of data cabling from MDF service zone workstation jacks.

5. Termination of voice, wap and CCTV cabling from MDF service zone workstation jacks

6. MDF- shall have multiple systems:

a. Category 6A Data - Rack Mounted
b. Fiber Optics Data- Rack Mounted
c. Category 6A horizontal voice cabling - Rack Mounted.
d. Intrusion detection and access control system- rack and back board mounted
e. Servers- Rack mounted
f. IPTV video distribution system- Rack mounted
g. Intra-building communications System Control Cabinet
h. Telecommunications and CATV entrance facilities.
i. CCTV system

B. Intermediate Distribution Frames: (IDF) are dedicated and secured rooms within the school that will host a satellite portion of the technology infrastructure equipment. 2 post equipment racks shall be provided as per the drawings in each IDF, which shall support:

1. Local area network (LAN) equipment including the switching, and uninterruptible power systems (UPS).

2. Termination of fiber cabling from MDF.

3. Termination of data cabling from IDF service zone workstation jacks.

4. Termination of voice cabling from IDF service zone workstation jacks.

5. Termination of CCTV cabling from IDF service zone.

6. Termination of IPTV cabling from IDF service zones.

7. Other system equipment if necessary

3.2 PROTECTION OF SYSTEMS AND EQUIPMENT

Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature and rain.

Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering them on sides with securely fastened protective rigid or flexible waterproof coverings.

During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum cleaned both inside and outside before testing, operating or painting.

As determined by the Owner, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the Contract Documents. Decision of the Owner shall be final.

Painted surfaces shall be protected with removable heavy kraft paper, sheet vinyl or equal, installed at the factory and removed prior to final inspection.

Damaged paint on equipment and materials shall be repainted with painting equipment and finished with same quality of paint and workmanship as used by manufacturer.

3.3 WORK PERFORMANCE

Coordinate location of equipment and conduit with other trades to minimize interference.

Holes through concrete and masonry in new and existing structures shall be cut with a diamond core drill or concrete saw upon approval of the structural engineer of record for the base building. Pneumatic hammer, impact electric, hand or manual hammer type drills shall not be allowed, except where permitted by the ARCHITECT and OWNER as require by limited working

space.

Holes shall be located so as not to affect structural sections such as ribs or beams.

Holes shall be laid out in advance. The ARCHITECT and OWNER shall be advised prior to drilling through structural sections, for determination of proper layout.

Structural Penetrations: Where conduits, wireways and other raceways pass through fire partitions, fire walls or walls and floors, provide an effective barrier against the spread of fire, smoke and gases.

3.4 ACCESS TO EQUIPMENT

Equipment shall be installed in a location and manner that will allow convenient access for maintenance and inspection.

Working spaces shall be not less than specified in the National Electrical Code for voltages specified.

Where the ARCHITECT and OWNER determine that the Communications Subcontractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled, one time only, as directed by the ARCHITECT and OWNER, at no additional cost to the Owner. “Conveniently accessible” is defined as being capable of being reached without the use of ladders or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and duct work.

3.5 CABLE TERMINATIONS AND DRESS

Installation of signal, video, communication and control conductors shall adhere to the following:

Cables shall be dressed, labeled and tie wrapped in cabinets, racks and/or at cross connect backboard to present a neat, logical and orderly installation. At the discretion of the Communications Subcontractor, cable duct with removable covers may be installed in equipment cabinets and control consoles to facilitate satisfying this requirement.

Cables shall be secured to equipment cabinet backboards, console members or to other system components using cable clamps and wraps. The Communications Subcontractor shall furnish and install cable support posts to facilitate system installation.

Cables and conductors shall be terminated with cable termination connectors compatible with the specific termination.

Metallic cables and conductors entering the facility from a point exterior to the building shall be equipped with lightning protection. Protector shall be located at the nearest point of cable entry in the building.

3.6 EXAMINATION

A. Examine pathway elements to receive cable. Check raceways, wire ways, cable trays and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Prior to the start of actual installation, the communications subcontractor shall review the exact location of all cables, outlets, and equipment with the Owner, Construction Manager and the suppliers of related equipment.

C. The communications subcontractor shall coordinate the equipment installation with the installation of raceways, to eliminate potential damage to cables.

3.7 INSTALLATION

A. Wiring Method: Install wiring with J-Hooks (except where cable tray is available). Comply with ANSI/TIA/EIA-569A for conduit sizing not indicated on Contract Drawings. Do not exceed the manufacturer's minimum bend radius. Comply with requirements listed in STELL DECKING specification (see related work section of this specification). The horizontal system cables shall be run using a star topology format from the MDF and/or IDFs rooms to the technology outlets as shown on the technology drawings. The length of each individual CAT 6A cable run between patch panels in the MDF and IDFs to each technology outlet or termination shall not exceed 300-ft. Cables may be routed through rooms and other spaces in the event that cable routing through main hallways negatively affects the requirement that the length of each individual cable run not to exceed 300-ft (90m) (terminated end to terminated end). Cabling which deviates from the main pathways shall be identified on the floor plans by the communications subcontractor.

B. Install components as indicated, according to manufacturers' written instructions. Use techniques practices, and methods that are consistent with the Category 6A rating of the components and that assure Category 6A performance of completed and linked signal paths, end-to-end.

C. Install cable without damaging conductors, shield, or jacket.

D. Do not bend cable in handling or installation to smaller radii than minimums recommended by manufacturers. Maintain recommended manufacturer's minimum bend radii of all UTP and fiber optic cabling at all times.

E. Pull cables without exceeding cable manufacturer's recommended pulling tensions.

1. Pull cables simultaneously where more than one is being installed in the same raceway.

2. Use "thin film" pulling lubricants only. It has been shown that lubricants will affect testing as the cable needs several weeks to dry before attenuation levels recover.

3. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage media or raceway.

F. Install exposed raceway parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.

G. Secure and support cable at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

H. Wiring within Wiring Closets and Enclosures: Provide adequate length of conductors. Train the conductors to terminal points with 24-inch extra cable neatly looped and secured properly. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to radii smaller than allowed.

I. Separation of Wires: Comply with ANSI/TIA/EIA-569A rules for separation of unshielded copper voice and data system cables from potential EMI sources, including electrical power lines and equipment and NEC Article 800-S2.

J. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.

K. Cables for data and voice shall be installed and terminated exactly as shown or described in the manufacturer's instructions.

L. Standards for each type of cable are very specific. Cable length, the bending radius of each turn, cutting back the sheath, length of untwisting and termination of the individual wires, stripping of the insulation displacing connections to the push-on terminals shall be performed strictly per manufacturer's instructions and any applicable standards.

M. Work area communications outlets shall be installed as shown on walls, floor or ceilings.

N. Jacks shall be installed as depicted on technology detail plans. Questions or discrepancies shall be reported to the owner.

O. Devices installed in the school will be of the same "Type and Manufacture".

P. All cables shall be routed in large groupings, through main hallways, until cable can be distributed directly to the communication outlet. Route individual cables to the appropriate outlet locations in accordance with all standards described herein.

Q. In suspended ceilings and corridors cable shall be bundled by type using Velcro cables ties snug, but not deforming the cable geometry and be supported via approved "J" style hooks attached to the existing building structure at a maximum of four (4) foot intervals. Use of ceiling tiles, grid or hanger wires for support of cabling is prohibited.

R. Do not install random or diagonal cable runs except for the reasons specified in item A above. Cable turns and bends shall be made at 90-degree angles whenever possible, but maintaining manufacturer's requirements for bending radius at all time.

S. All cables, which enter conduit stubs of technology outlets in fixed wall locations, shall be installed with a minimum of a 3'service loop of cable secured above the ceiling where the cable enters the conduit at each outlet. A 3' service loop of cable shall also be provided in the cable tray above the data patch panel racks. Provide a service loop of cabling for each cable installed above the ceiling

T. All cables which penetrate a steel stud or steel wall cap, wall section and where a cable enters a conduit shall be protected from damage with a "stud liner".

U. All cables entering power poles, surface mounted raceway, or other cable management systems shall be protected from damage.

V. Cabling shall be extended between floors utilizing inter-floor conduit provided under 26 00 00. See network riser drawing for cable pathways.

W. Conduit and sleeves provided as a means of routing cables between various rooms and floors, and those which remain (empty) as spare, shall be sealed with an approved fireproof, removable safing material. Sleeves, which pass vertically from floor to floor, shall be sealed in a similar manner using an approved re-enterable system. Additional penetrations through rated assemblies necessary for passage of wiring shall be made using an approved method, coordination with the General Contractor and permanently sealed after installation of cables.

X. Meet all requirements regarding use of cable in return air plenums (SEE 1.3.C. above) and in raised floor systems. Provide wiring that complies with all applicable state, local building codes, and the National Electrical Code. All cables run in raised floor systems with forced air-cooling shall meet the requirements of Article 645, “Electronic Computer Data Processing Equipment” of the NEC.

Y. Cables installed partially or fully within the MDF and IDFs are to be routed through and secured in the cable tray wherever possible. Cables placed in the cable tray are to be laced or tie wrapped with Velcro tie wraps frequently to keep them neatly bundled and not permitted to shift from one side of the tray to the other as they are routed in the tray.

Z. Provide one voice station cable (Cat6A) from the MDF (home run) to EACH elevator equipment room. Route cable to elevator control cable termination in elevator equipment room as noted on drawings. Leave 30 feet of slack for connection by subcontractor responsible for the elevator phone connection. Terminate, label and crosswire elevator phone and connect cable to the line provided by Local Exchange Carrier. Verify proper room and location with elevator subcontractor.

AA. Secure all equipment racks with threaded rod to cable tray (if installed) above racks.

3.8 GROUNDING

A. Installation

1. The communications subcontractor of this section shall provide grounding and bonding in accordance with the requirements of NFPA 70, IEEE 142, EIA/TIA 568, EIA/TIA 607, state and local codes, and to requirements specified herein. Codes shall be complied with as a minimum requirement, with qualification standards prevailing when they are more stringent.

B. Bonding

1. Metallic conduits, wireways, metal enclosures of busways, cable boxes, equipment housings, all racks and all non-current carrying metallic parts of the installed communications services shall be grounded. The metallic conduit system shall be used for equipment and enclosure grounding but not as a system ground conductor. A code sized green insulated copper grounding conductor shall be included in nonmetallic conduits, and each end shall be terminated on suitable lug, bus, or bushing.

2. All conduit stub-ups shall be grounded, and where multiple stub-ups are made within an equipment enclosure, they shall be equipped with grounding bushings and bonded together and to the enclosure and the enclosure ground bus.

3. Each metallic raceway, pipe, duct and other metal object entering the buildings shall be bonded together and all conduits entering the building shall be labeled. The communications subcontractor shall use #6 AWG copper conductors.

4. The communications subcontractor of this section shall bond communications equipment and busbars separately.

5. The electrical subcontractor shall install the main telecommunications grounding bus bar.

6. Provide appropriate ground for Directv system that is to be roof mounted. Cable pathing for Directv system shall be in 2” conduit as shown on the drawings in the MDF.

C. Signal Reference Grounding and Bonding

1. Each identified communications space within a building shall have a common signal reference ground. The signal reference ground shall conform to the following:

   a. Within the building, all communication spaces shall be separately bonded to each other and connected to the primary building ground in accordance with the provisions of EIA/TIA 607. The communication ground shall not ground any other equipment or be connected to any potential high voltage source. All racks, frames, drain wires, and all installed communication equipment shall be grounded to this common reference ground only.

   b. Communications subcontractor of this section must provide, as a minimum, a continuous #6 AWG green electrical conductor connected to a 1/4" x 4" x 5.25" telecommunications grounding bus bar (TGB) 6" AFF on the plywood backboard of each IDF and the TV Studio to terminate chassis, racks, and other equipment grounds, unless otherwise specified.

   c. The ground wires from each individual IDF and the TV Studio Head End and Control Room shall be routed directly to the main telecommunications ground bus bar in the MDF room, terminated and bonded together via a telecommunications main grounding bus bar (TMGB) of minimum 1/4" x 4" x 12" dimensions. This point of single reference for all closets in a building shall in turn be grounded with a minimum #0 ground conductor to an acceptable building ground of 5 ohms or less. An acceptable building ground for signal reference is the building service entrance ground. Electrical subcontractor must supply the grounding bus bar.

D. Riser / Tie Cabling Grounding

1. There shall be no bonding between the entry cable and the inside riser or distribution cable.

2. All riser and tie cable shields shall be bonded into a single continuous path end-to-end and grounded on each floor in which pairs leave the sheath. Cable shields shall be grounded to the signal reference ground provided in each telecommunication space.

E. Field Tests

1. As an exception to requirements that may be stated elsewhere in the agreement with the District, the Inspector shall be given 5 working days notice prior to each test. The communications subcontractor of this section shall provide all test equipment and personnel and shall provide written copies of all test results.

2. Grounding and bonding system conductors and connections shall be inspected for tightness and proper installation.

3.9 CLEANING

During construction, and prior to Owner acceptance of the building, remove from the premises and dispose of packing material and debris caused by telecommunications work.

Remove dust and debris from interiors and exteriors of electrical equipment. Clean accessible current carrying elements prior to being energized.

3.10 COMPLETION

General: Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and similar items. Leave the premises clean, neat and orderly.

Results Expected: Systems shall be complete and operational and controls shall be set and calibrated. Testing, start-up and cleaning work shall be complete.

Maintenance Materials: Special tools for proper operation and maintenance of the equipment provided under this Specification shall be delivered to the Owner.

3.11 TESTING AND ACCEPTANCE CRITERIA

A. Fiber Optic Cabling

1. Scope of Certification Testing

a. Each fiber optic data cable and associated outlet/connector shall be 100% identified and tested. It is the responsibility of the communications subcontractor of this section to ensure the design/equipment provided/methods used provides acceptable total link loss to ensure a high performance 10GB backbone.

2. Certification Tests

a. At a minimum, provide the results from the following performance tests on all installed fiber optic data cabling as outlined in ANSI/TIA/EIA-568-B.3-2000, along with the respective addenda, ANSI/TIA/EIA 526-A and TIA 568-B.1. MM fiber shall be tested at 850nm and 1300nm in accordance with ANSI/TIA/EIA 526-14A method B and SM fiber shall be tested at 1310nm and 1550nm in accordance with ANSI/TIA/EIA 526-14A method A.1

b. Record all fibers length and total attentuation

c. Note that all of these tests are required for each strand of the fiber optic data cable.

d. In addition to these, any performance tests required by the cabling product vendor for issuing and honoring the required 15-year warranty must also be performed.

e. Approved accuracy testing equipment must be used for all tests.

B. UTP Cabling (Data/Voice/WAP/CCTV, Other)

1. If cable manufacturer requires field AXT testing for its Cat 6a solution/warranty, Communications Subcontractor is to test to the TIA-568-B.2-10 and TIA 568B.1 permanent link testing standards and the following requirements within this specification.

2. Cabling systems shall meet or exceed the electrical and transmission characteristics of the systems specified.

3. Cable segments and links shall be tested from both ends of the cable for each of the construction phases. (Verify that cable labeling matches at both ends).

4. The system shall not be considered certified until the tester has acknowledged that the performance of the physical layer of the system has been fully tested and is operational at the completion of the installation phase.

5. After the installation is complete, in addition to any other required testing as described herein, and at such times as the Owner/Engineer directs, the communications subcontractor shall be present while the Owner conducts an operating test for approval. The installation shall be demonstrated to be in accordance with the requirements of this specification. Any defects revealed shall be corrected promptly at the communications subcontractor's expense and the tests performed again.

6. After review of the completed test results, the Owner reserves the right to retest cables, utilizing the communications subcontractor's tester and the communications subcontractor's labor.

7. Alien Crosstalk Testing Preparation:

   a) Alien Crosstalk (AXT) testing measures the unwanted noise coupled to the cable being tested (called the "Victim" or "Disturbed") by six surrounding cables (called "Disturbers"). Two tests need to be performed: the Power Sum Alien Near-end Crosstalk (PSANEXT) test and the Power Sum Alien Attenuation-to-Crosstalk Ratio, Far-end (PSAACRF) test. Results for the remaining AXT tests are taken as part of these two, so although they are not directly provided, a "pass" result for PSANEXT and PSAACRF ensures passing results for AACRF, AFEXT, ANEXT, and PSAFEXT. A 2% sample of the installed cables is typically recommended: testing the longest cables in the installation will provide the most meaningful results.

   b) AXT testing requires special planning, equipment and training:

      1. AXT tests are time consuming. Budget AXT test time into the project bid.

      2. Handheld test instruments (field testers) require an adjunct AXT module.

         3. A laptop computer is also used with the field tester.

         4. The field tester's AXT application software must be loaded onto the laptop.

         5. Installation personnel will require training prior to performing AXT testing.

8. Field Testing Equipment: Submit during shop drawing review on the testing equipment to be utilized on this project. The communications subcontractor shall test all cables installed under this Section.

   a) Category 6a Testing Equipment:

      1. Testing shall be accomplished using a UL Level IV field tester capable of testing to 500 MHz. Ensure that the tester has any necessary hardware or software upgrades, including AXT testing capabilities for testing Cat 6a installations.

      2. Provide factory calibration report of field test equipment.

9. Testing Procedures:

a) Testing shall conform to the TIA 568B.2-10, TIA 568B.2 and TIA-568-C.2 standards.

b) Testing will be to the Permanent Link Test Parameters.

c) A 2% sample of the installed cables is typically recommended: testing the longest cables in the installation will provide the most meaningful results.

d) Tests shall be based on each pair of conductors and not the aggregate multiple pair results.

e) Test cable segments end-to-end, from the telecommunications room horizontal patch panel/cross connect block panel to each work area outlet and from each telecommunications room backbone patch panel/cross-connect block panel to respective main cross connect, and from the work area outlet to the main cross-connect (through patch cables or cross- connect wiring) with a Signal Injector, Graphical Link Testing Meter and Time Domain Reflectometer (TDR) for compliance to latest TIA performance requirements.

f) Provide report indicating failures and what actions were taken to ensure a passing horizontal cable and its terminations. Any cable failing the certification test (Fail, Fail* or, Pass*) must have remedial work done to provide a full pass test result; Remediation may include retermination or replacement of the cable, which fails. No cables passing within tolerance only (Conditional Pass*) will be accepted. Remedial work shall be at no cost to the Owner."

C. Test Plan

1. All test equipment, test procedures, and testing techniques shall be specified in the acceptance test plan and will require approval prior to execution.

2. Tests shall be conducted by the communications subcontractor of this section in accordance with the approved Test Plan.

3. The purpose of this testing is to verify that the installed system meets all specified attenuation and bandwidth requirements and is capable of being used for its intended purpose.

4. Test results shall be submitted for approval. Manufactured or assembled products or equipment shall be tested as indicated, and the results submitted to the District's technical representative for approval, prior to shipment to the site.

5. The communications subcontractor of this section shall prepare a test plan which provides a detailed outline of all testing to be accomplished.

6. The test plan shall include, as a minimum, a schedule of when tests will be performed (relative to installation milestones), specific test procedure that will be used, a list of test equipment that will be used (manufacturer, model number, range, resolution accuracy) and shall conform to the specified requirements of other sections of this specification.

D. Test results:

1. The test results information for each link shall be recorded in the memory of the field tester upon completion of the test. The tester shall be capable of storing test data in either internal or external memory. The external media used shall be left to the discretion of the user.

2. Test results saved by the tester shall be transferred into a Windows based database utility that allows for maintenance, inspection and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered as well as any printed reports generated from the software application.

3. Optional formats of data reporting are: comma separated variable (.csv), Portable Document File (.pdf) or compatible, plain text (.txt), or hypertext markup language (.html/.htm).

4. Test Results shall include the following:

   a) Applicable room number of jack location (room number per Contract Documents)
   b) Applicable Telecommunications Room number
   c) Circuit I.D. number with corresponding jack identifier
   d) Wire Map – shall include the following:
      1. Continuity to the remote end
      2. Shorts between any two or more conductors
      3. Crossed pairs
      4. Reversed pairs
      5. Split pairs
      6. Any other miswiring
   e) Length
   f) Insertion Loss
   g) Near-end Crosstalk (NEXT) Loss
   h) PS-NEXT (Power Sum Near End Cross Talk)
   i) FEXT (Far End Crosstalk)
   j) ELFEXT (Equal Level Far End Cross Talk)
   k) PS-ELFEXT (Power Sum Equal Level Far End Cross Talk)
   l) Propagation Delay
   m) Delay Skew
   n) Return loss
   o) PSFEXT (Power Sum Far End Crosstalk)
   p) PSACRF (Power Sum Attenuation to Crosstalk Ratio, Far End)
   q) AACRF (Alend Attenuation to Crosstalk ratio, Far End)
   r) AFEXT (Alien Far End Crosstalk)
   s) ANEXT (Alien Near End Crosstalk)
   t) PSANEXT (Power Sum Alien Near End Crosstalk)
   u) PSAACRF (Power Sum Alien Attenuation to Crosstalk Ratio, Far End)

END OF SECTION

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Section 27 21 33

DATA COMMUNICATIONS WIRELESS ACCESS POINTS

PART 1- GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of a Contract, including conditions of the Contract and Division 1 of the Specifications, shall apply to the Work in this Section.

B. Drawings and general provisions of the Contract, including all portions of the Project Manual are hereby made a part of this Section. Refer to paragraph titled “Quality Assurance” in this section and to Division 1 for requirements for Communications Subcontractors. Throughout this and related Sections, “Subcontractor” shall not be limited to the singular and masculine and shall refer to one, or more than one, Communications Subcontractor. The Terms “Communications Subcontractor” and “Communications System Integrator “ shall be used interchangeably and shall be understood to represent the communications subcontractor responsible for the furnishing, configuring, testing, programming, warranting and ensuring all work is performed in accordance with manufacturer’s requirements and recommendations for the work identified in this SECTION.

C. Any qualifications or certificates required in this specification may be requested by the Architect as part of the post-bid qualifications review. Such review shall commence subsequent to the bid submission, as none of this information is required as part of the bid submission. In the event that the Architect requests qualification or certification documentation such documentation shall be provided within 3 business days.

1.2 SUMMARY

A. Work Included. The scope of work of this Section consists of the procurement, configuration, programming, testing and warranting of all wireless network electronics and materials to be furnished under this SECTION, and without limiting the generality thereof, consists of providing all labor, materials, equipment, plant, transportation, appurtenances and services necessary and/or incidental to properly complete all equipment work as shown on the drawings, as described in the specifications, or as reasonable inferred from either or, in the opinion of the Owner, as being required and in general, is as follows:

1. Provide, install and test all wireless equipment, modules, mounts, power supplies, chassis, power cords, and licenses that create the wireless network environment. Configure equipment as per Owner direction.
2. Provide, install and test wireless access points in locations specified by the owner.
3. All wireless access points shall be installed below the ceiling tiles unless noted otherwise.
4. Provide heat coverage maps and adjust as necessary after the WAPs are installed. Turn over heat maps to owner once the configuration and installation is final.
5. Provide and install all patch cords from the WAP to the above ceiling or wall data outlet. All patch cords shall be Cat6A, Green in color, and shall be hidden from view behind the WAP device. All WAP device status lights shall be orientated in the same direction when installed.
6. Locate WAPs for best coverage in the space, and to avoid any interferences.
7. Wap outlets in the control booth of the auditorium, the hallway outside the media center on the third floor, in the hallway on the second floor outside the carpentry and automotive rooms, and the pressbox shall have the patch cords to the wap devices run through the conduit noted on the drawings to allow the wap devices to be placed as noted.

8. Adjustments to wap positions shall be made after the heat maps (provided by contractor of this section after the system is fully installed and operational) are procured to ensure even coverage throughout the building as per the owner's direction.

B. The work of this Section is shown on Technology Drawings numbers designated by a T.

C. No corridors or spaces are air plenums. No cabling needs to be plenum rated.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. All Sections of Division 27.

B. SECTION 05 31 00 – STEEL DECKING See for restrictions concerning the hanging of material, cable tray, mounts, brackets, hooks, and other items from the roof or decking

C. SECTION 01 23 00 - ALTERNATES

D. The following related work or material shall be provided under the designated trades and under the listed SECTION:

1. Specialty Equipment: DIVISION 11, "EQUIPMENT"

2. Field Painting: DIVISION 9, "FINISHES"

3. HVAC Equipment: DIVISION 23 00 00, "HVAC"

4. Electrical: DIVISION 26 00 00, "ELECTRICAL"

5. All SECTIONS of DIVISION 27 and 28

E. Unless otherwise indicated, the following work is not included as part of the Communication Subcontracor's responsibilities in this SECTION, except for coordination, and is to be performed as indicated:

1. Empty conduits to accessible point above or below floor shall be provided by the electrical subcontractor.

2. Floor boxes and poke through devices shall be provided by the electrical subcontractor.

3. Standard device boxes with plaster rings for data shall be provided and installed by the electrical subcontractor.

4. Clock system backboxes shall be installed by the electrical subcontractor and provided by the 27 50 00 Communications Subcontractor.

5. Telephone system, installation and cross connections and devices provided by the Owner.

6. Speaker/paging system backboxes shall be installed by the electrical subcontractor and provided by the 27 50 00 Communications Subcontractor.

7. Structural blocking to support wall and ceiling mounted equipment shall be provided by the General Contractor.

8. Computers and monitors and final connections to outlets shall be provided by the Owner.

9. Interface with public utilities telephone service shall be arranged and provided by the Owner.

10. Wide Area Network connections shall be arranged and provided by the Owner.

11. CATV service and connections to installed systems shall be arranged and provided by the Owner.

12. Single-Mode and Multimode fiber, terminations and patch cords

13. Equipment racks

14. Switches (Provided by Owner)

6. The installation, operating cost and maintenance of the controlled environmental conditions, for equipment located on site, as cited by the manufacturer, NFPA 70B, or as specified in these specifications shall be the responsibility of the General Contractor.

1.4 SYSTEM DESCRIPTION

A. Specified Manufacturer: To establish a standard of quality, design and function desired, Drawings and specifications have been based on the Adtran Bluesocket wireless equipment listed below.

Manufacturer:	Item:	Part Number:
ADTRAN	CEILING MOUNT WIRELESS ACCESS POINT	1700954F1
ADTRAN	WALL MOUNT WIRELESS ACCESS POINT	1700955F1
ADTRAN	OUTDOOR WIRELESS ACCESS POINT	1700952F1
ADTRAN	LICENSES	NA

B. Acceptable Substitutions: The product(s) specified above have been determined to be in the public interest based on sound reasoning and voted as proprietary by the Owner. Under provisions of Massachusetts General Laws, Chapter 30, Section 39M(b) and Chapter 149, other equal products not named herein, may be considered for acceptance as an equal by the Architect and Owner upon submission of complete product information as described in Section 01 25 13 - Product Substitution Procedures. Further additional information may be requested by the Owner or Architect for determination that the proposed product substitution is fully equal to the specified product(s). There is no guarantee that proposed substitutions will be approved, and the Communications Subcontractor shall not to order any materials until approval(s) are received in writing.
   1. Requesting substitutions shall be at the Communications Subcontractor's own risk, with regard to uncompensated delays of the Project. Time will be required for sufficient review and additional requests for information by the Architect and Owner. Delays which result from substitution reviews and resubmissions are not grounds for additional time or cost change orders, and will not be considered by the Awarding Authority.

D. Coordination: Coordinate device locations in equipment racks with other trades and the

Owner.

1.5 REFERENCE SPECIFICATIONS, STANDARDS AND CODES

A. Comply with the referenced codes and standards and with the Contract Documents. Where conflicts occur, the more stringent shall apply.

B. Work shall meet or exceed the standards and procedures of the following:

American National Standards Institute (ANSI)
Building Industry Consulting Service International (BICSI)
National Electrical Manufacturers Association (NEMA)
Telecommunications Industries Association (TIA)
Electronic Industries Association (EIA)
National Electrical Safety Code (NESC)
Institute of Electrical & Electronics Engineers (IEEE)
Underwriters Laboratories (UL)
National Fire Protection Association (NFPA)
American Standards Association (ASA)
Federal Communications Commission (FCC)
Occupational Safety and Health Administration (OSHA)
American Society of Testing Material (ASTM)
National Electric Code (NEC)
Americans with Disabilities Act (ADA)
In the event of conflicts, the more stringent provisions shall apply.

1.6 COORDINATION

A. When articles, materials, operations or methods related to execution of telecommunications work are noted, specified, or described in the specifications or are indicated or reasonably implied on drawings and schedules, execute work as appropriate to provide complete and proper function, operation and installation.

B. The drawings utilize symbols and schematic diagrams to indicate items of work. These symbols and diagrams will not typically identify dimensions nor will they identify inclusion of specific accessories, appurtenances and related items necessary and appropriate for a complete and proper installation and operation. The Communications Subcontractor shall install work complete and ready for proper operation, including related items not specifically identified, shown, indicated or specified. The work shall be installed, in accordance with the intent diagrammatically expressed on the drawings, and in conformity with the dimensions indicated on architectural drawings and on shop drawings approved by the Communications Subcontractor and Architect. When abbreviations appear on the drawings or specifications in upper or lower case letters, with or without periods, the resultant work shall be as stated above.

C. The drawings include details for various items, which are specific with regard to the dimensions and positioning of the work. These details are intended only for the purpose of establishing general feasibility. They do not obviate field coordination for the indicated work. Work shall not proceed until actual field conditions and requirements are verified by the

Communications Subcontractor.

D. The drawings are diagrammatic and indicate the general arrangement of systems and equipment unless indicated otherwise by dimensions.

1.7 SUBMITTALS

A. General: Architect may require submittal submission within 45 days of bid award. Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections, Section 01300 and Section 26 00 00. Submittals shall be made as one complete package.

B. The Submittal shall include, but shall not be limited to the following:

1. Product Data for each component specified, including detailed manufacturer's specifications. Include data on features, ratings, and performance. Include dimensioned plan and elevation views of components. Provide an index and tabulated pages referencing the equipment in the specification. Any submittal received without a full index and tabulated pages shall be returned without action.

2. Provide qualification/certification data for firms and persons specified in the "Quality Assurance" article to demonstrate their capabilities and experience. Provide evidence of applicable registration or certification.

3. Field test and observation reports from qualified inspecting and testing personnel indicating and interpreting test results relative to compliance with performance requirements of the installed systems.

4. Evidence of listing of products specified to be listed in the "Quality Assurance" article.

5. Shop drawings, prepared in AutoCAD, readable in AutoCAD Release 2010 or newer, detailing the cabling systems.

C. Shop drawing submittals shall include but shall not be limited to the following:

1. As Builts indicating the following:

a. Locations of all devices and cabling with identification numbers, port number of faceplate, and MAC addresses, IP number and serial numbers of each wireless piece of equipment installed.

b. Cable schedule showing building location, WAP identifier, MAC address, serial number, IP number, outlet number and corresponding patch panel port identifier in the local IDF or MDF.

2. Rack risers showing controller locations with closet numbers, if applicable.

D. Device Schedules: Prior to substantial completion, prepare and submit location schedules for each of the devices installed under this section describing the as-built condition of the systems. Prepare device schedules in tabular form. Include the following information in each schedule:

1. Device Schedule:

a. Serial number

b. MAC address
c. Location
d. Faceplate port number device is connected to and service closet port number
e. Device IP number.

E. It is intended for the Submittal data to be complete and accurate at the first submission. If the submittal is returned marked “Resubmit” only one additional submission will be permitted. IF THE SECOND SUBMITTAL IS NOT ACCEPTABLE, OR IF THE SUBMITTAL IS NOT MADE WITHIN THE SPECIFIED TIME FRAME, THE RIGHT OF SUBSTITUTION AND SELECTION WILL BE LOST. THE OWNER WILL SELECT THE SPECIFIED ITEM. THAT ITEM IS TO BE PROVIDED AND SHALL BE PROVIDED AT NO ADDITIONAL COST.

F. A minimum period of 15 working days, exclusive of transmittal time, will be required in the Owner’s office each time Shop Drawings, Product Data, layout drawings, catalog data and brochures are submitted or resubmitted for review. A minimum period of 20 working days exclusive of transmittal time will be required for reviewing substitute materials or manufacturer. These time periods shall be considered when scheduling the work.

G. If proposed equipment deviates from the Specification or Drawings, indicate in writing on Company letterhead those differences and provide sufficient data to justify acceptance. FAILURE TO INDICATE DEVIATION OR SUBSTITUTIONS IMPLIES FULL COMPLIANCE WITH DRAWINGS AND SPECIFICATIONS.

1.8 RECORD DRAWINGS

Provide Record Drawings in accordance with Division 1 for requirements regarding Project Record Documents.

“As- Built” record documentation for telecommunications work shall include:

System function diagrams.
Communications flow diagrams.
Manufacturers’ description literature for equipment.
Connection and programming schedules as appropriate.
Equipment material list including quantities.
Spare parts list with quantities.
Details not on original Contract Documents.
Test Results
Warranties
Release of Liens
Heat Maps of the installed system. Adjustments to wap positions shall be made after the heat maps are procured to ensure even coverage throughout the building as per the owner’s direction.

Operation and Maintenance Manual:

Refer to Section 01 33 00 - Submittals for requirements pertaining to Operation and Maintenance Data.

The Communication Subcontractor shall submit manuals in accordance with Division 1 containing manufacturers’ brochures of items installed by the Communication Subcontractor.

The manual shall be subdivided into separate sections with tab dividers to identify subsystems of the integrated system. Reference appropriate specification sections.

Provide the following additional information for each electronic system. Information shall be edited for this project where applicable.

Operations manuals for components and for system as a whole.

Maintenance manuals for components and for system as a whole.

Point-to-point diagrams, cabling diagrams, construction details and cable labeling details.

List of spare parts, materials and suppliers of components. Provide name, address and telephone number for each supplier.

Emergency instructions for operational and maintenance requirements.

Delivery time frame for replacement of component parts from suppliers.

Recommend inspection schedule and procedures for components and for system as a whole.

Complete “Reviewed” shop drawings and product data for components and system as a whole.

Troubleshooting procedures for each system and for each major system component.

Closeout Submittals:

1. As-Built Drawings: Update Shop Drawings to create final As-Built Drawings. Submit 3 copies digitally in AutoCAD 2010 or later format on a CD with criteria noted above.
2. Operation Data: Include three (3) copies of the software Administrator and Operator Manuals.
3. Maintenance Data: Include three (3) copies: maintenance and repair procedures.
4. Digital copies of all training materials and DVD videos of all training provided on CD and DVDs.
5. Estimated costs for maintenance and software assurance for the system on a yearly basis.
6. Submit costs for repairs and service not covered under warranty (ie: owner requested changes, acts of God, vandalism, misuse, etc).
7. Final Heat Maps showing coverage
8. Warranty certificate with contact numbers with appropriate start and stop dates. Warranty shall not commence until the system is accepted by the owner.
9. PDF of product data and O&M manuals shall contain bookmarks for every section and

item submitted.

1.9 QUALITY ASSURANCE

Equipment and materials required for installation under these specifications shall be the current model and new (less than one [1] year from date of manufacture), unused and without blemish or defect.

A. Communications subcontractor: must be certified by the manufacturer to procure, install, configure and warrant listed products.

B. Comply with the following:

1. ANSI/TIA/EIA-568-B, Commercial Building Telecommunications Cabling Standard.

2. ANSI/TIA/EIA-568-B.1, Commercial Building Standard for Telecommunications Cabling Standard Part 1 General Requirements, 2001.

3. ANSI/TIA/EIA-568-B.2, Commercial Building Standard for Telecommunications Cabling Standard Part 2, Balanced Twisted Pair.

4. ANSI/TIA/EIA-568-B.3 and B.3-1, Optical Fiber Cabling Components Standard

5. ANSI/TIA/EIA-526-7 Measurement of Optical Power Lossof Installed Single-Mode Fiber Cable Plant.

6. ANSI/TIA/EIA-14A Measurement of Optical Power Lossof Installed Multimode Fiber Cable Plant.

7. ANSI/TIA/EIA-569-A, Commercial Building Standard for Telecommunications Pathways and Spaces.

8. ANSI/TIA/EIA-606, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

9. ANSI/TIA/EIA-607, Commercial Building Grounding and Bonding Requirements for Telecommunications.

10. BISCI Telecommunications Distribution Methods Manual Standards, Latest Volume.

C. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms “Listed” and “Labeled”: As defined in the National Electrical Code, Article 100.

D. Work Coordination: Coordinate Work of this Section with School’s provided telephone switch and telephone instruments, planned equipment, wide area network (WAN), and the Technology Director of the School District.

1. Record agreements reached in meetings and distribute record to all participants in the meetings.

E. Communications subcontractor must be certified by the manufacturer to procure, service and warrant wireless system for the past 5 years. Provide proof of manufacturers’ certification for

systems to be furnished.

1.10 WARRANTY AND SERVICE AGREEMENT

A. All equipment, materials, and labor shall be guaranteed for a period of 36 months from the date of final acceptance by the Owner. Warranty shall begin at this time, not the date of substantial completion. Systems must be fully operational, and accepted by the owner after training before the warranty is to begin.

B. The manufacturer or communications subcontractor shall repair or replace malfunctioning products at no expense to the Owner, except failures caused by damage or unreasonable use.

C. Communications subcontractor shall maintain regular service facilities and a help desk. Provide qualified technicians that are experts in Bluesocket wireless equipment, and who are familiar with the work at the site, within 24 hours of receipt of a notice of malfunction, excluding weekends and holidays.

1. Provide material, devices, equipment, and personnel necessary for repairs.

D. Provide accepted temporary, alternate equipment, if required by the Owner, complete and operational within 48 hours after notification of malfunction, at no additional cost during the first year of warranty.

E. Communications subcontractor shall conduct warranty repairs and service at the project site unless prohibited by manufacturer's warranty. If the latter, communications subcontractor shall provide substitute systems, equipment, and devices acceptable to the Owner for the duration of the off-site repairs. Replace items out of service more than 10 days with new equipment during the warranty period.

F. Communications subcontractor shall transport warranty equipment, substitute systems, test systems, equipment, devices, materials, parts, and personnel to and from the project site at no additional cost to the Owner.

G. Provide any software maintenance updates or upgrades to all devices comprising of the wireless system at no additional cost to the Owner for this 36 month period.

H. Response Times - Normal business hours shall be 7 AM to 5 PM Monday through Friday. Calls for service before noon shall be responded to on-site before the end of the day. Calls after noon shall be responded to on-site by noon the following business day.

I. Provide extra costs for time outside of normal business hours if the Owner requires emergency service.

J. Submit an all-inclusive Annual Maintenance Agreement and software assurance agreement cost for years 4 and 5, in the close out submittals.

K. Submit normal and after hours labor costs and typical costs for equipment for items not covered under the Warranty, like: Acts of God, vandalism, misuse.

L. Service Calls: Provide 24 hours of service calls on system for the school after final acceptance to make any adjustments necessary to keep system at peak operating condition. Warranty work is not included in the service call time.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be suitably packaged by manufacturers to prevent damage during shipment and handling. Damaged materials will not be acceptable for use.

B. Store materials on site in clean, dry storage area. Do not install equipment until the IDFs, MDF and other areas can be secured and controlled.

1.12 ALTERNATES

A. Alternate 2 - Storage/Support/Restroom Facility. All related work on T2.4 for the facility shall not be included in the base bid. This work shall be included in the ALTERNATE 2 bid. This work includes the procurement, licensing, installation and testing of 3 ceiling mounted WAP devices specified below. The quantity below in 2.3 does NOT include these three (3) devices in the count.

PART 2 - PRODUCTS

MATERIALS:

Provide all mounts required to install the different types of devices.

No patch cable shall be visible from below the WAP device. Neatly and cleanly run the cable above the ceiling to the WAP faceplate data port.

Align all WAPs in a similar fashion, such that the status lights are viewable from the classroom doorways.

When more than one WAP is to be installed in a single location (such as the control booth fascia in the auditorium the café, the gym, etc) the WAPs shall be installed symmetrical (all the status lights and or antenna facing the same way unless this impacts performance in a particular location).

2.1 UPS (UNINTERRUPTABLE POWER SUPPLIES, WHERE REQUIRED)

A. Provide in every rack that contains wireless equipment a rack mounted uninterruptable power supply with the capacity to support all the wireless equipment in the rack under full load for 7 minutes. Size according to equipment installed. All UPS devices shall report their status via the network. Coordinate with Owner. Provide patch cable and connect and configure UPS devices in accordance with Owner direction. Provide UPS network management cards as necessary. UPS must have 120v 30 amp twist lock plug.

2.2 PROTECTIVE ENCLOSURE

A. Provide and install protective enclosure for all wireless access points installed in the gym.

2.3 WIRELESS ACCESS NETWORK EQUIPMENT

A. Provide the following in the quantities listed:

Specified Manufacturer: To establish a standard of quality, design and function desired, Drawings and specifications have been based on the Adtran Bluesocket wireless equipment listed below.

Manuf:	Item:	Part Number:	Qty:
ADTRAN	CEILING MOUNT WIRELESS ACCESS POINT	1700954F1	113

ADTRAN	WALL MOUNT WIRELESS ACCESS POINT	1700955F1	10
ADTRAN	OUTDOOR WIRELESS ACCESS POINT	1700952F1	1
ADTRAN	ANTENNA KITS FOR OUTDOOR WAPS	1700930F1	1
ADTRAN	LICENSES	NA	AR

B. The products listed above shall be configured and installed by the communications subcontractor of this section. Note that OWAP symbol designates that a WAP faceplate is inside the building, and the WAP is to be installed on the outside of the building via the provided conduit at the location (see press box). Seal all conduits after installing patch cords. Provide a bracket to mount the WAP to the wall in the outdoor space. Provide other equipment as necessary for a complete and functional wireless network installation. Mount all wireless access points below ceiling tiles unless wall mounted or noted otherwise). Provide green Cat6a patch cord of sufficient length and connect wireless access point to WAP4/OWAP outlet. A WAP4/OWAP location on the drawings with a circle around it denotes where a device is to be placed, unless noted that the device is placed at the end of the local conduit run (conduit run is for parch cord). A WAP4/OWAP location without a circle does not have a WAP device installed at that location.

PART 3 - EXECUTION

3.1 PROTECTION OF SYSTEMS AND EQUIPMENT

Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature and rain.

Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering them on sides with securely fastened protective rigid or flexible waterproof coverings.

During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum cleaned both inside and outside before testing, operating or painting.

As determined by the Owner, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the Contract Documents. Decision of the Owner shall be final.

Painted surfaces shall be protected with removable heavy kraft paper, sheet vinyl or equal, installed at the factory and removed prior to final inspection.

Damaged paint on equipment and materials shall be repainted with painting equipment and finished with same quality of paint and workmanship as used by manufacturer.

3.2 WORK PERFORMANCE

Coordinate location of equipment with other trades to minimize interference.

3.3 ACCESS TO EQUIPMENT

Equipment shall be installed in a location and manner that will allow convenient access for maintenance and inspection.

Working spaces shall be not less than specified in the National Electrical Code for voltages specified.

Where the ARCHITECT and OWNER determine that the Communications Subcontractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled, one time only, as directed by the ARCHITECT and OWNER, at no additional cost to the Owner. “Conveniently accessible” is defined as being capable of being reached without the use of ladders or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and duct work.

3.4 CABLE TERMINATIONS AND DRESS

Installation of signal, video, communication and control conductors shall adhere to the following:

Cables shall be dressed, labeled and tie wrapped in cabinets, racks and/or at cross connect backboard to present a neat, logical and orderly installation. At the discretion of the Communications Subcontractor, cable duct with removable covers may be installed in equipment cabinets and control consoles to facilitate satisfying this requirement.

Cables shall be secured to equipment cabinet backboards, console members or to other system components using cable clamps and wraps. The Communications Subcontractor shall furnish and install cable support posts to facilitate system installation.

Cables and conductors shall be terminated with cable termination connectors compatible with the specific termination.

Metallic cables and conductors entering the facility from a point exterior to the building shall be equipped with lightning protection. Protector shall be located at the nearest point of cable entry in the building.

3.5 EXAMINATION

A. Examine pathway elements to receive cable. Check raceways, wire ways, cable trays and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Prior to the start of actual installation, the communications subcontractor shall review the exact location of all cables, outlets, and equipment with the Owner, Construction Manager and the suppliers of related equipment.

C. The communications subcontractor shall coordinate the equipment installation with the installation of raceways to eliminate potential damage to cables.

3.6 INSTALLATION

A. Do not bend cable in handling or installation to smaller radii than minimums recommended by

manufacturers. Maintain recommended manufacturer's minimum bend radii of all UTP and fiber optic cabling at all times.

B. Devices installed in the school will be of the same "Type and Manufacture".

C. All waps shall be installed with indicator/status lights facing the same direction.

D. All patch cords shall be hidden from view, behind the waps.

3.7 CLEANING

During construction, and prior to Owner acceptance of the building, remove from the premises and dispose of packing material and debris caused by telecommunications work.

Remove dust and debris from interiors and exteriors of electrical equipment. Clean accessible current carrying elements prior to being energized.

3.8 TRAINING

A. Provide systems demonstration and instructions on configuring, troubleshooting and maintaining system. Provide a minimum of 8 hours for training. Provide the Owner with a training program designed to make all administrative control configurations clearly understood, simple and easy to use.

B. Employ manufacturer's field representative to demonstrate system operation to designated Owner personnel.

C. Use submitted operation and maintenance manual as reference during demonstration and training.

D. Submit field reports indicating satisfactory installation and testing of system.

E. All training materials shall be provided to the owner in digital format, and all training shall be video recorded and provided to the owner on DVDs.

3.9 COMPLETION

General: Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and similar items. Leave the premises clean, neat and orderly.

Results Expected:

Systems shall be complete and operational and controls shall be set and calibrated. Testing, start-up and cleaning work shall be complete.

Maintenance Materials: Special tools for proper operation and maintenance of the equipment provided under this Specification shall be delivered to the Owner.

3.10 TESTING AND ACCEPTANCE CRITERIA

A. Test Plan

1. The communications subcontractor of this section shall prepare a test plan which provides a detailed outline of all testing to be accomplished. Submit test plan to Owner for approval.

2. Tests shall be conducted by the communications subcontractor of this section in accordance with the approved Test Plan.

3. The purpose of this testing is to verify that the installed system meets all bandwidth requirements and is capable of being used for its intended purpose.

4. Test results shall be submitted for approval. Manufactured or assembled products or equipment shall be tested as indicated, and the results submitted to the District's technical representative for approval.

5. The test plan shall include, as a minimum, a schedule of when tests will be performed (relative to installation milestones), specific test procedure that will be used, a list of test equipment that will be used (manufacturer, model number, range, resolution accuracy) and shall conform to the specified requirements of other sections of this specification.

B. Test Results

1. Each test sheet shall have a sign-off blank for the communications subcontractor of this section, as well as the District's technical representative. Copies of the completed test forms or test results shall be delivered according to the shop drawing procedures.

2. The communications subcontractor of this section shall maintain an accurate test record during all field tests. Any communication subcontractor-developed format for recording test data shall be submitted for approval as part of the test plan.

END OF SECTION

Section 27 40 00

AUDIO - VIDEO COMMUNICATIONS
(FILED SUB-BID REQUIRED AS PART OF SECTION 26 00 01)

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Sub-Bid Requirements: As provided under Section 26 00 01 – Electrical Filed Sub-Bid Requirements and supplemented under the Bidding Requirements, Contract Forms, and Conditions of the Contract, and applicable parts of Division 1 - General Requirements.
   1. Work of this Filed Sub-Bid includes all individual specification sections listed in Section 26 00 01

1.2 RELATED DOCUMENTS

A. The General Provisions of a Contract, including conditions of the Contract and Division 1 of the Specifications, shall apply to the Work in this Section.

B. Drawings and general provisions of the Contract, including all portions of the Project Manual are hereby made a part of this Section. Refer to paragraph titled "Quality Assurance" in this section and to Division 1 for requirements for Communications Subcontractors. Throughout this and related Sections, "Subcontractor" shall not be limited to the singular and masculine and shall refer to one, or more than one, Communications Subcontractor. The Terms "Communications Subcontractor" and "Communications System Integrator" shall be used interchangeably and shall be understood to represent the bidder responsible for all work identified in this SECTION.

C. Any qualifications or certificates required in this specification may be requested by the Architect as part of the post-bid qualifications review. Such review shall commence subsequent to the bid submission, as none of this information is required as part of the bid submission. In the event that the Architect requests qualification or certification documentation such documentation shall be provided within 3 business days.

1.3 SUMMARY

A. Work Included. The scope of work of this Section consists of the designing, installation, and programming of all materials to be furnished under this SECTION, and without limiting the generality thereof, consists of providing all labor, materials, equipment, plant, transportation, appurtenances and services necessary and/or incidental to properly complete all work as shown on the drawings, as described in the specifications, or as reasonable inferred from either or, in the opinion of the Architect and Owner, as being required and in general, is as follows:
   1. Classroom local sound system installation and wiring (system provided by owner), interactive projectors (projector provided and installed by subcontractor of this section), and voice amplification/mixing system installation and wiring (system provided by owner).
   2. Conference Rooms and Media Center local sound system installation and wiring (system provided by owner), interactive projectors (projector provided and installed by subcontractor of this section), and voice amplification/mixing system installation and wiring (system provided by owner).
   3. Local sound systems for the Press Box, Gymnasium, Student Dining, and PE Alternative Room and Storage/Support Facility. (storage/support facility is Alternate

2, see paragraph 1.13 below for bidding requirements).

4. Auditorium and Auditorium Control Room audio, video and control system.
5. Small Group Seminar audio, video, video teleconferencing and control systems.
6. TV Studio remote camera broadcasting locations (V8A symbol).
7. The following faceplate (See T2.0 and T2.1) cabling, terminations and installation responsibilities are part of this section: Microphones (M in a circle, with a number subset next to circle for more than one jack on the plate), HM (hanging microphones), SPr, SPr2, T1A, R1, R2, S1, S2, B1 to B1, B2, B3, V8A, V2, V3, V6, V7, IP, V1, VA, A (attenuator, where noted that the attenuator is for an SPr speaker: 163A, 163B).
8. Various cabling termination for systems to include low voltage wire for complete and functional systems.
9. Intercom System for TV Studio
10. All low voltage control wire shall be one continuous run. No splices are permitted.
11. Provide and install a roof mounted AM/FM antenna cabled to the MDF then distributed to all AM/FM tuners specified herein to allow for a clear radio signal within the building. Provide appropriate distribution and amplification for a fully functional system.
12. Provide and install cable to connect all R2 plates to the output of the local sound system.
13. All software and drivers for equipment provided in this section shall be provided to the owner on CDs by Feb 28, 2017 for inclusion in the owner's PC images.
14. All mounting plates, cables and jacks for Audio Visual connections in floor boxes and poke through devices (floor boxes and poke through devices provided and installed by electrical subcontractor). Coordinate jacks/mounts required with 260000 subcontractor approved floor boxes and poke through devices.

B. Actual control room and rack layouts will be based upon the specific designs submitted by the communications subcontractors. Needs for audio processing equipment, specific speakers, and other equipment will be dependent on actual product manufacturers and communications subcontractors design. Communications subcontractors shall coordinate room layout, actual speaker and equipment placement, programming options, and control panel screens with architect prior to installation.

C. Provide and install:

1. Assembly and setup of the systems for normal operation, testing, and training of operators and users.
2. Permanently installed sound reinforcement systems and equipment racks including the processing equipment, compact disc player, iPod player, audio & video equipment, mixers, and amplifiers.
3. Equipment racks, and power supplies.
4. New microphones and microphone jacks.
5. New Speakers. Press Box, Auditorium, Small Group Seminar, and Gymnasium systems shall include all rigging hardware necessary to mount speakers. Conference Rooms (speakers provided by Owner, installed by subcontractor of this section), Band and Chorus rooms (speakers provided by owner, installed by subcontractor of this section, plus new speakers specified), Classrooms (speakers provided by owner, installed by subcontractor of this section), PE Alternative (new ceiling mounted speakers), Storage/Support Facility (new pendant mount speakers) and Student Dining (new pendant and ceiling mounted speakers). Provide and install wall mounted speakers in Library where shown on the drawings.
6. All labor, programming, design, tuning, cabling, terminations and system configuration.
7. All audio signal equalization, processing, delay programming, testing and any other

equipment, cabling and devices to provide design intent shown on the drawings and described in the specifications.

D. Install 93 owner provided classroom systems, to include per classroom/conference room/library location (one system at each interactive projector location): Lightspeed voice lift system, Ligthspeed sensor, two microphones, 4 ceiling speakers (2 where shown on the drawings), and an SDP-860 document camera. All cabling shall be new and not reused when installing in the new school. Provide and install new PA mute circuit to Lightspeed system for Lightspeed to mute upon PA announcement. Provide and install all tile bridges for speakers. Owner shall provide owner provided equipment to the communications subcontractor no later than 27 April 2017. Communications subcontractor of this section shall coordinate and schedule work for owner provided equipment with this date and the project completion date in mind when scheduling work and work crews to complete the AV installation.

1.4 RELATED WORK SPECIFIED ELSEWHERE

A. All Sections of Division 27.

B. SECTION 05 31 00 – STEEL DECKING See section for restrictions concerning the hanging of material, cable tray, mounts, brackets, hooks, and other items from the roof or decking.

C. SECTION 01 23 00 – ALTERNATES

D. The following related work or material shall be provided under the designated trades and under the listed SECTION:

1. SECTION 11 52 13 - PROJECTION SCREENS
2. SECTION 12 30 00 - MODULAR CASEWORK
3. SECTION 26 00 00 - ELECTRICAL All electrical work related to items in this Section and coordinate input to auditorium sound system for muting purposes upon fire alarm activation. Coordinate work at gym ceiling to avoid conflicts with speaker and antenna placements with ceiling mounted fans.
4. SECTION 27 70 00 – VIDEO DISTRIBUTION SYSTEM (faceplate connections (T1, VA) for STB, coordinate cable pulls through conduits)
5. SECTION 10 14 00 SIGNAGE – Coordinate work at gym ceiling to avoid signage installed from obstructing speaker audio dispersion.
6. SECTION 11 66 23 GYM EQUIPMENT – Coordinate work at gym ceiling to avoid conflicts with speaker and antenna placements with ceiling mounted gym equipment.
7. SECTION 11 66 24 BASKETBALL EQUIPMENT - Coordinate work at gym ceiling to avoid conflicts with speaker and antenna placements with ceiling mounted basketball equipment.
8. SECTION 11 66 53 GYM DIVIDERS - Coordinate work at gym ceiling to avoid conflicts with speaker and antenna placements with gym dividers.
9. SECTION 23 00 00, 21 00 00 & 22 00 00 HVAC, FIRE SUPRESSION & PLUMBING - Coordinate work at gym ceiling to avoid conflicts with speaker and antenna placements with HVAC, fire suppression and plumbing systems.

1.5 SYSTEM DESCRIPTION

Specified Manufacturer: To establish a standard of quality, design and function desired, Drawings and specifications have been based on the following equipment listed below:

Manufacturer:	Item:	Part Number:
EPSON	BRIGHTLINK INTERACTIVE PROJECTOR	595Wi

Acceptable Substitutions: The product(s) specified above have been determined to be in the public interest based on sound reasoning and voted as proprietary by the Owner. Under provisions of Massachusetts General Laws, Chapter 30, Section 39M(b) and Chapter 149, other equal products not named herein, may be considered for acceptance as an equal by the Architect and Owner upon submission of complete product information as described in Section 01 25 13 - Product Substitution Procedures. Further additional information may be requested by the Owner or Architect for determination that the proposed product substitution is fully equal to the specified product(s). There is no guarantee that proposed substitutions will be approved, and the Communications Subcontractor shall not to order any materials until approval(s) are received in writing.

1. Requesting substitutions shall be at the Communications Subcontractor's own risk, with regard to uncompensated delays of the Project. Time will be required for sufficient review and additional requests for information by the Architect and Owner. Delays which result from substitution reviews and re-submissions are not grounds for additional time or cost change orders, and will not be considered by the Awarding Authority.

NOTE: ALL wireless systems, (such as microphones, assistive listening, touch panels) specified herein require the communications subcontractors to provide appropriate amplifiers, distribution amplifiers, antennas and antenna placements, cabling, rigging, and related components to ensure full space coverage for microphones and assistive listening systems, and full use of the wireless touch panels (and other devices as specified 'wireless') within the space. Provide additional antennas, cabling and distribution equipment to ensure full space coverage.

A. Classrooms - Typical: Classrooms locations shall be equipped with audio and video equipment to assist the instructor. System includes local audio reinforcement, wall mounted ultra-short throw interactive projector, and voice amplification/mixer equipment. Desktop and laptop computers will be provided by owner prior to system acceptance. Subcontractor of this section shall install the owner provided voice lift, presentation camera and 4 ceiling speakers (2 where shown on the drawings) at every classroom interactive projector location, and provide and install new cabling for the equipment provided by the owner and the subcontractor of this section.

B. Interactive Conference Rooms and Library Interactive areas- Typical: Interactive Conference Room locations and Library interactive locations shall be equipped with audio and video equipment to assist the presenter. System includes local audio reinforcement, wall mounted ultra-short throw interactive projector, and voice amplification/mixer equipment. Desktop and laptop computer will be provided by owner prior to system acceptance. Subcontractor of this section shall install the owner provided voice lift, presentation camera and 2 ceiling speakers at every conference room interactive projector location, 2 wall mounted speakers (subcontractor of this section shall provide and install wall speakers) at both Library interactive locations, and provide and install new cabling for the equipment provided by the owner and the subcontractor of this section.

C. Auditorium
   1. The Auditorium is a multipurpose space used for drama, music, and lectures in both performance and teaching situations. The audiovisual system is divided into five sub-systems. These systems include: live sound, hands off sound reinforcement, AV presentation, recording/monitoring, and control
   2. Live sound system for use in drama and music productions. This system will include:

a. Five channels, separate frequency, UHF wireless microphone receivers with body pack transmitters and headset microphones
b. Multiple microphone inputs available, at a minimum at stage right, stage left, stage rear and on the apron. See drawings for locations.
c. 48 mixing channels plus 6 stereo returns for a total of 60 channels. Main (LCR) outputs, 16 AUX buses, 8 matrices. Configurable to 90 inputs and 90 outputs depending on Digital Snake configuration. 4-band advanced parametric EQ, and delays on all inputs and outputs. Compressors and Gates on all mixing channels. Six built-in stereo (dual-mono) multi-effects and twelve graphic EQs (switchable to 8-band PEQs). 214 possible output patch points on each port (A,B, console). Allows direct routing from preamp to output point without having to use mix channel. Supports integration with Personal Mixing System and Multi-Channel Live Recording/Playback. Cascade connection supports large format applications for 96 mixing channels
d. CD and MP3 player
e. Roll top desk for console and ancillary equipment
f. Programmable DSP systems for audio system routing, and speaker alignment and tuning
g. Line array speaker system with Sub-woofers to provided even coverage throughout the auditorium.
h. Capability of 5.1 full bandwidth surround system reproduction and mixing
i. Power amplifiers
j. Six channel monitors use in productions and presentations mixed from the Front of House mixing console
k. Assisted listening system for the hearing impaired
l. AM/FM tuner
m. Portable microphones, stands, and cables

3. Hands off sound reinforcement system for use in lectures and assemblies. This system will share the same loudspeakers as live sound system through the programmable DSP system. This system does not require an AV technician to operate and will include:
   a. Two of the five wireless microphones
   b. Multiple microphone inputs located around the stage (as noted Auto Mic) and at the center of house (where noted Auto Mic). The mic jacks shall be engraved “AUOT MIC #” where # is the number of the auto mic.
4. AV system for presentations, lectures and teaching to the entire Auditorium and classes held on the stage. This system will share the same loudspeakers as live sound system through the programmable DSP system. System includes high lumen projector and long throw lens.
5. Recording/Monitoring system for recording productions, lectures, and classes for archive and teaching purposes. This system will also be used to distribute audio to stage monitors. This system will include:
   a. Three High Definition Digital color cameras with auto iris zoom lens mounted at V1 locations in the auditorium. Cabling and faceplate details to be provided by communications subcontractors when systems are submitted.
   b. Blu-Ray player
   c. High Definition Media recorder
   d. Two Shot Gun microphones (on light bar, shown on drawings)
   e. Speakers for practice rooms and in the control booth
   f. Routing and distribution as needed.

6. Integrated controls system to allow simplified control of the presentation, and recording systems. This system will allow a user to control presentation source selection, transports, projector functions, lighting presets, and turn the system on and off. This system will include:
   a. An integrated controller with multiple serial, digital, and analog control ports
   b. Two color touch panels for use at the sound-mixing console and in the control booth with custom software to provide a user-friendly control.

D. Small Group Seminar - Room shall be equipped with the following:
1. Sound Reinforcement System with program loudspeakers.
2. 16 Channel Audio Digital Signal Processor, and source materials
3. Video projector with long throw lens, and video source and switching equipment.
4. Mixer
5. TCP/IP based teleconferencing system with presenter and audience cameras.
6. Unified wireless touch panel control system for all presentation, audio, lighting, and projection screen features and functions.
7. Wireless microphone system and wireless assistive listening system.

E. Gymnasium
1. Sound Reinforcement System with program loudspeakers. System must be configured to patrician for separate audio combining to support: a full gym; ½ gym and ½ gym; ¼ gym and ¼ gym and ½ gym configurations.
2. Rack mounted multi-channel sound mixer, and source audio equipment.
3. Wireless microphone system and assistive listening system

F. PE Alternative
1. Mounted sound reinforcement system with loudspeakers.
2. Rack mounted multi-channel sound mixer, and source audio components.
3. Wireless microphone system

G. Student Dining
1. Sound Reinforcement System with program loudspeakers.
2. Rack mounted multi-channel sound mixer, and source audio equipment.
3. Wireless microphone system and assistive listening system
4. Video projector and long throw lens for presentation using V6/V7 to projector screen.

H. Storage/Support Facility - ALTERNATE 2
1. Sound Reinforcement System with program loudspeakers.
2. Rack mounted multi-channel sound mixer, and source audio equipment.
3. Wireless microphone system and assistive listening system

I. Coordination: Coordinate device locations with furnishings and equipment.

1.6 SUBMITTALS
A. Architect may require submittal submission within 45 days of bid award. Submit 3 copies of the following as part of the submittals.
1. A list describing at least 5 installations comparable in scope and nature as specified. Include the name, current position, address, and telephone number of a representative of each installation owner.
2. Provide a listing of test equipment including a list showing procedures and service contacts.
3. A complete list of quantities, including materials, components, devices, and equipment required for the Work. Tabulate the list of quantities for the components

of each system as specified, and provide the following information for each item listed:
a. Quantity.
b. Description.
c. Manufacturer's name and model number.
d. Corresponding specification section and article number.

Non-tabulated and indexed submittals shall be returned without action.

4. Corrected items as applicable for resubmitted, as specified above.
5. Complete, comprehensive, single-line diagrams in computer aided drafting (CAD) format including equipment, devices, connectors, wiring, and wire numbering completely identified. Include label designations and locations. One-Line signal flow drawings shall be submitted with specific equipment bid.
6. Complete, scaled (1" = 1'-0" minimum) in CAD format, equipment rack elevation drawings, including equipment designation, manufacturer's name, model number, rack location, and rack designation, and sample touch screen layouts for the integrated control systems.
7. Complete catalog cut sheets and manufacturer's literature.

B. Closeout Submittals:
1. Copy of FCC license for Hearing Assistance System FM transmitters.
2. Copy of certificate of cables complying with fire retardant requirements.
3. Closeout Submittals: Submit 3 record drawings to the Owner.
4. Owners/Operations manuals for all installed equipment. Provide in a three ring binder.
5. Updated one line system flow diagrams.
6. A simple to follow laminated placard on the inside of the door of each sound system showing how to turn on and use the basic sound system. Roll top desk shall include a placard for automic mixer use.
7. PDF of product data and O&M manuals shall contain bookmarks for every section and item submitted.

1.7 QUALITY ASSURANCE

A. Manufacturers' Requirements:
1. Manufacturer's products shall have been satisfactorily used in similar service for a minimum of 3 years.

B. Bidder Qualifications:
1. A firm with a minimum of 5 years successful installation experience similar in scope with this project.
2. Bidder shall be primarily engaged in the procurement, design, installation, and maintenance of commercial duty audio and video systems. Bidder must be certified by the manufacturer to procure, install, configure, program and warrant the equipment.
3. Bidder must hold a valid CTS-D Certification from the International Communications Industries Association.
4. Bidder installing technicians must hold a valid CTS-I Certification from the International Communications Industries Association.
5. Bidder installing technician shall be certified by the video and audio control system manufacturer if programming of control equipment is required.
6. Bidder must provide a CTS Certified project manager that provides weekly progress reports to owner on installation progress, attends job meetings, and visits the site at least weekly during equipment installation.

C. Code Compliance: Comply with national, state, and local electrical and structural codes as

applicable to installation and construction of the sound reinforcement system.

D. Provide equipment listed and labeled by Underwriters Laboratories (UL).

E. Sound Pressure Level (spl): Provide a range of 80 to 90 dBspl for the listeners in any location in the Auditorium, Small Group Seminar, Gymnasium, Student Dining and PE Alternative. Comply with ANSI S13-1971 (R1986).

F. All wiring shall be in raceways and conduits.

G. All equipment AC power shall have lightning surge protection.

1.8 WARRANTY

A. Communications subcontractor shall warrant all work free from defects in materials and labor for 36 months from the date of owner acceptance, not the date of substantial completion. Provide minimum 3-year parts and labor warranty for all systems/components.

B. The manufacturer or communications subcontractor shall repair or replace malfunctioning products at no expense to the Owner, except failures caused by damage or unreasonable use.

C. Communications subcontractor shall maintain regular service facilities and provide a qualified technician familiar with the work at the site within 24 hours of receipt of a notice of malfunction, excluding weekends and holidays.
   1. Provide material, devices, equipment, and personnel necessary for repairs.
   2. Provide accepted temporary, alternate equipment, if required by the Owner, complete and operational within 48 hours after notification of malfunction, at no additional cost during the first year of warranty.

D. Communications subcontractor shall conduct warranty repairs and service at the project site unless prohibited by manufacturer's warranty. If the latter, communications subcontractor shall provide substitute systems, equipment, and devices acceptable to the Owner for the duration of the off-site repairs. Replace items out of service more than 10 days with new equipment during the warranty period.

E. Communications subcontractor shall transport warranty equipment, substitute systems, test systems, equipment, devices, materials, parts, and personnel to and from the project site at no additional cost to the Owner. All travel expenses shall be included in the warranty.

1.9 DELIVERY, STORAGE AND HANDLING

A. Handle equipment components carefully to prevent breakage, denting, and scoring the finish.

B. Do not install damaged equipment. Replace and return damaged units to equipment manufacturer.

C. Store equipment in a clean, dry space, in original cartons and protect from dirt, physical damage, weather, and construction traffic. Protect electronic components from dust debris and water.

1.10 SEQUENCING

A. Furnish a listing of test equipment presently owned and to be used for this project. Include make, model number, serial number, and the date of last equipment calibration. Test equipment shall be calibrated within the past 24 months of contract award.

B. Test Equipment: Furnish, store, and maintain the following test equipment at the job site for both routine and performance testing of this work. After testing, remove equipment from the site.
   1. Oscilloscope B/W-130Mhz, Sens-1mV/cm
   2. Digital Multi-meter 1 percent accuracy
   3. Analog O.M. Simpson 260 or Fluke equivalent
   4. Function Generator B/W-1MHz, Distortion <1 percent
   5. Real Time Analyzer 1/3 Octave with calibrated microphone
   6. Pink Noise Source B/W-20Hz-20KHz
   7. Impedance Meter Range 20Hz-20KHz, 1 Ohm-50KOhm
   8. Impedance Bridge Sennheiser ZP-3 or equivalent
   9. Precision Test mic B & K Model 4006, or equivalent, Omni
   10. Directional microphone.

1.11 OWNER'S INSTRUCTION

A. Provide on-site training to the Owners personnel and technical staff on the use of the audio/visual systems; 16 hours minimum (blocks of 4 hours) for auditorium equipment; 8 hours minimum for Small Group Seminar equipment; 8 hours minimum for classroom systems, 8 hours min for remainder of system equipment (Cafe, Gym, PE Alternative, Storage/Support Facility). Provide 4 hours on Press Box system equipment. Communications subcontractor technician shall be present at first public use of Gym, Café, Auditorium, pressbox and Small Group Seminar systems to assist owner with function and use of system.

B. Provide 3 copies of the manual service books (classroom systems, Small Group Seminar, Auditorium, Student Dining, PE Alternative, Storage/Support Facility, Press Box and Gym). Provide a full parts list of all equipment delivered.

C. All training materials shall be provided to the owner in digital format, and all training shall be video recorded and provided to the owner on DVDs.

1.12 MAINTENANCE

A. Manual: Prepare and submit, before acceptance testing, copies of an operations and maintenance manual, neatly bound, indexed and tabulated. Provide 3 copies for the Owner's use. Manual shall include:
   1. Basic power on/off and operational procedures.
   2. Manufacturer's service literature for each major system component.
   3. A system block diagram with input/output termination's identified including wiring diagrams.
   4. A copy of the verification test report.
   5. Each copy shall contain the systems for the Auditorium, Gym, Small Group Seminar, Student Dining, and PE Alternative and typical classroom setup, to include IPTV control of projectors and TVs. Coordinate this requirement with the 27 70 00 communications subcontractor.

1.13 ALTERNATES

A. Alternate 2 – Storage/Support/Restroom Facility. All related work on T2.4 and specified herein for the facility shall not be included in the base bid. This work shall be included in the ALTERNATE 2 bid. This work includes associated sound system, PA system muting, sound system speakers, installation, cabling, training and testing.

PART 2 - PRODUCTS

2.0 Specified Manufacturer: To establish a standard of quality, design and function desired, Drawings and specifications have been based on the following equipment listed below:

Manufacturer:	Item:	Part Number:	QTY:
EPSON	BRIGHTLINK PROJECTOR	595Wi	93

Acceptable Substitutions: The product(s) specified above have been determined to be in the public interest based on sound reasoning and voted as proprietary by the Owner. Under provisions of Massachusetts General Laws, Chapter 30, Section 39M(b) and Chapter 149, other equal products not named herein, may be considered for acceptance as an equal by the Architect and Owner upon submission of complete product information as described in Section 01 25 13 - Product Substitution Procedures. Further additional information may be requested by the Owner or Architect for determination that the proposed product substitution is fully equal to the specified product(s). There is no guarantee that proposed substitutions will be approved, and the Communications Subcontractor shall not to order any materials until approval(s) are received in writing.

A. Requesting substitutions shall be at the Communications Subcontractor's own risk, with regard to uncompensated delays of the Project. Time will be required for sufficient review and additional requests for information by the Architect and Owner. Delays which result from substitution reviews and resubmissions are not grounds for additional time or cost change orders, and will not be considered by the Awarding Authority.

2.1 Classrooms and Interactive Conference Rooms (Typical) (93 total: 91 Classrooms & Conference rooms, 2 in Library):

A. General:
1. Rooms shall be equipped with audio reinforcement, voice amplification, projector video presentation and interactivity. Equipment shall be mounted in a provided permanent fixture in each classroom.
2. Equipment shall be mounted within the furniture to provide a fixed installation. Connections to devices in teacher desk location will be provided via the classroom technology outlet faceplates (T1). Communications subcontractor must provide all cabling cross connections.
3. This specification is designed to define the desired operating criteria and suggested equipment. Communications subcontractor shall design and provide a fully operational system including labor, materials, and equipment.
4. Install in each interactive location (Qty 93) the owner provided equipment for each room (Lightspeed voice lift system, Presentation camera, 4 ceiling speakers (2 in places shown on the drawings). Provide and install new cabling for all equipment).
5. Install owner provided presentation camera in Small Group Seminar.

B. Capabilities: The system shall provide the following capabilities:
1. Ability to activate and control the projector to select media source inputs from the IPTV software. Coordinate connections and functions with 27 70 00 communications subcontractor.
2. An interactive projection system and projector mount that is mounted on the teaching wall of the classroom, which can interact with a desktop or laptop computer installed within the room. The desktop and laptop computers are not part of this specification.
3. Display of the local desktop or laptop computer (computers provided by Owner).
4. Distribute audio from source equipment clearly to the entire room.
5. Amplify and distribute teacher's voice clearly to the entire room.

6. Display IPTV channels via the IPTV set top box (provided by owner and installed by 27 70 00 communications subcontractor)

C. Products:

1. Interactive Projector (provide 93 total). Proprietary – Epson 595Wi
   a. Provide and install a compact ultra-short throw wall mounted projector for the display of WXGA/ computer signals, NTSC, NTSC 4.43, PAL, SECAM, PAL-60, DVD & HDTV video signals. Projector shall be controlled by RS-232 communications for remote control functions via the IPTV system.
   b. Projector shall be a minimum of 3300 ANSI lumens, and must be bright enough to provide a detailed imagine on the interactive whiteboard mounted within the room with moderate sun light.
   c. Projector must meet the following specifications:
      1. Ultra-short throw (projector and mount shall not extend beyond 3' from wall)
      2. Native Resolution- 1280 x 800
      3. Color reproduction – up to 1.07 billion
      4. Input terminals: HDMI x2, VGA, Audio- RCA x 2 (Stereo), Ethernet, RS-232
      5. Contrast ratio up to 10,000:1
   d. Provide and install the provided ultra-short throw projector wall mount
   e. Projector shall be physically aligned on the mount to achieve the native splash screen filling the board as the installation instructions dictate. The Finger Touch Unit shall be installed such that the Finger Touch Unit installation parameters are met using the native raster of the projector. No more than 4% of digital zoom may be used. Image shall be within 4" of each side of the board. Finger Touch Unit shall be installed above the white board, not on it. All other manufacturer's installation parameters shall be met. Adjust pitch/roll/yaw of projector to achieve proper image on board.
   f. Provide, install and configure projector b/g/n wireless module option at all projector locations.
   g. Connect VGA and HDMI cables to projector inputs, and a 3.5mm audio cable from projector output to T1 faceplate.
2. Speakers (Qty 324 ceiling type (owner provided), Qty 4 new wall type (Library))
   a. Provide and install four (see drawings) new wall mounted 30 watt speakers. Speakers shall be connected to the audio amplifier/mixer to provide sound reinforcement to the classroom. Speakers shall be installed to provide even sound coverage in the space.
   b. Speaker color shall be white.
   c. Speaker shall have a frequency range of 115hz-16khz.
   d. The speakers shall be 8 ohm
   e. Speakers (4) are Atlas Sound SM42T-W, alternates by TOA, JBL or equal.
   f. Install and cable 322 ceiling speakers (speakers provided by owner) and provide and install tile bridges, at SPr locations in classrooms and conference rooms.
   g. Install and cable two ceiling speakers (speakers provided by owner) each with tile bridge (provided by communication subcontractor of this section), one in 163A and one in 163B. Provide and install a 35w attenuator in each room to fully cut these speakers out. These speakers are to be cabled/installed to the audio output of the auditorium. These speakers are provided by the owner but all tile bridges are provided by the communications subcontractor of this section.
3. Cabling – Provide and install at each interactive location: (NOTE: all HDMI cables must be 24AWG or larger diameter. All HDMI cables connected to wall plates shall

use a cable lock mechanism to secure the cable to the wallplate.)

a. All HDMI and DVI cabling required. Provide and install one HDMI cable from IPTV STB (IPTV set top box provided by owner) HDMI INPUT 1 which must extend 4' min outside of builtin (T1) to allow for laptop connection (laptop provided by owner). Provide and install one DVI to HDMI cable from IPTV STB HDMI input 2 which must extend 4' min outside of builtin (T1) and connect to document camera (document camera provided by owner). Provide and install HDMI cable from IPTV STB HDMI OUT to projector HDMI input on T1 faceplate.

b. At T1 faceplate provide and install HDMI, VGA and 3.5mm audio cables from T1 faceplate to projector connections via the VA grommet faceplate at projector.

c. All audio cabling required. Provide and install 3.5mm audio cable from projector to back of T1 3.5mm audio jack. Provide and install 3.5mm audio cable from T1 jack to voice lift AUX input.Voice lift system provided by owner. Provide and install 3.5mm audio cable from COMP input on voice lift system to outside of builtin, extending 4' outside the builtin for laptop connections. Provide and install 3.5mm audio to RCA L&R cable from audio out of IPTV STB to voicelift TV/VCR input. Provide and install an RCA L&R to 3.5mm audio cable from the voicelift CD/DVD input to the shelf the IPTV STB is on. Leave coiled 3' for owner device input.

d. Provide VGA cable from T1 faceplate to the outside of the builtin, extending 4' outside the builtin for laptop connection. A breakaway or rapid run VGA cable shall be used from the T1 faceplate in wall to the projector.

e. Any other cabling required for a complete and operational system (mute circuit, IR mic sensor cable, speaker cabling).

f. Provide and install 9 conductor (coordinate with 277000 communications subcontractor) RS-232 cabling from classroom cabinet (leave coiled 4' inside cabinet, RS232 terminations and connectors provided and installed by 277000) to projector. Leave coiled 3' at projector. Terminations and connectors for RS232 at projector by 277000.

g. Provide and install USB cabling, cat6 cabling and USB extenders. Connect all cabling such that 4' of USB cable extends outside the T1 builtin for laptop connection, to the projector USB port for the interactivity requirement of the projector. USB extender is C2G 29341 or equal by Monoprice or B&B Electronics.

h. Cables from back of T1 faceplate shall run direct to projector via the VA grommet faceplate. Grommet on T1 shall be to run speaker cabling, sensor cabling, PA mute circuit cabling, USB cabling to projector and RS-232 cabling to projector.

i. Provide and install LightSpeed mic sensor cable, and PA mute circuit from room PA speaker to LightSpeed voice lift system for PA override of LightSpeed audio. Place mic sensor in room to ensure no audio dropouts.

j. All cables shall be dressed and secured for a neat and professional appearance. All labels shall be square and plumb. Label all terminations.

4. Other

a. All B1 faceplates, HDMI jacks and active HDMI cables and B1 to B1 locations as shown on the drawings. Where shown on the drawings, provide and install active HDMI amplified cable of appropriate length to connect the local B1 faceplates HDMI jack to the local projector HDMI 2 input in classrooms via the VA grommet faceplate. In offices or spaces with TVs, provide and install the B1 active HDMI cable to the HDMI B1 at the TV. Label all faceplates "To Projector HDMI 2" or "To TV HDMI 2" or the appropriate TV HDMI input number. HDMI cable from B1 behind TVs to TV

HDMI input is provided and installed by 277000 communications subcontractor.

2.2 Auditorium

A. General:

1. Auditorium shall be equipped with a local sound reinforcement system with front left and right line array speakers, subwoofers, stage monitor speakers, control room speakers, and speakers in practice rooms. Line array, booth and practice rooms speakers shall be mounted, or hung in permanent locations. Stage monitor speakers shall be movable.
2. Sound mixing console and audio program equipment shall be installed within a roll top desk with dual 19" equipment racks (left and right) to be installed center of house. Communications subcontractor must provide the desk, and size appropriately for mixing board, phone, room control touch panel, desk space, wireless receiver/transmitter units and audio source components.
3 Production intercommunications equipment, amplifiers, crossovers, feedback eliminators, delay processors, graphic equalizers, control system equipment, video projector, and video source equipment shall be mounted in a rack(s) within the Auditorium control room. Communications subcontractor must provide appropriate racks to mount equipment specified.
4. Video projector and source equipment.
5. Wireless devices such as microphones and assistive listing systems shall have antennas mounted in the area that provides the full service coverage, while not impeding the view, or architectural design of the space.
6. All microphones shall be cabled to the microphone rack at the stage.
7. Provide and install all Cat6 cables for the digital snakes from the microphone rack to the center of house, and from the control booth to the center of house.
8. The DSP system shall provide an Automatic Microphone function, initiated by the touch panels, whereby the designated microphones (labeled "Auto-mic #) shall be presented over the sound system in the auditorium without the need for an audio-visual technician at the COH mixer board. An 'Auto-mic' button shall be available on the touch panel and once initiated, the automic microphone outputs will be presented over the sound system for hands free operation.
9. This specification is designed to define the desired operating criteria and suggested equipment. Communications subcontractors shall design and provide a fully operational system including labor, materials, and equipment including wall plates for speakers and other devices as shown on the drawings and as specified.

B. Capabilities:

1. The system shall provide the following capabilities:
   a. Ability to power-up, select, and control media source materials, control pre-set room lighting scenes, raise and lower projection screen, and open/close front curtain (if curtain is motorized), from touch panels to be installed by 27 40 00 communications subcontractor, located at both the center of house roll top desk, and the Auditorium control room.
   b. PA Emergency All Call from office will override any current program material. Provide and install equipment to accomplish audio system muting.
   c. System must be tied into the fire alarm system and upon fire alarm activation, a warning message shall be displayed on the touch panels and all programing muted. Coordinate requirement with fire alarm subcontractor, who will provide an output from the fire panel. 27 40 00 communications subcontractor shall provide the means to accomplish above requirement.
   d. All microphones shall be cabled to and terminated at stage microphone rack as shown on the drawings. Wireless microphone receivers shall be installed at

CoH roll top desk racks. Two of the five wireless microphones shall be 'split' as specified below for 'automic' function. Label receivers and microphones accordingly.

C. Products:

1. 48 Channel Sound Board.

a. The digital mixer shall be designed as an integrated system including Ethernet audio transmission, digital audio processing, integrated digital recording using an optional USB memory key, and digital mixing. The system shall have the ability to be expanded to a maximum of 90 physical inputs and 90 physical outputs using up to 2 input and output modules. The system shall have two Ethernet transmission ports that can each be connected to an input module comprising an 8-input stage box, a 16-input stage box or a modular 40-channel input box. The inputs shall be of very high quality and accept both line and microphone level inputs with individually selectable phantom power. The input gains or trims shall be controllable in 1 dB increments and these settings, as well as their phantom power settings, shall be remotely controllable from the mixing control surface. The gain and phantom power parameters shall be stored with the channel settings for recall later.

b. The mixing system shall include a mixing control surface that includes 25 touch-sensitive moving faders. It shall also include 25 Mute buttons, 25 Solo buttons and 25 Select buttons. Pressing the Select button shall return the display to the selected channel or bus's Edit screen. There shall be 3 buttons that assign 24 of the faders to control channels 1-24, channels 25-48, or the buses. A fourth button shall assign the faders to control the individual User Fader settings for the selected User. It shall also have a dedicated Touch Sense button for turning the touch sensitive fader function on and off. It shall also have a dedicated Sends on Fader button allowing fader control of each channel's send level to the selected bus. It shall also have 16 knobs dedicated to adjusting the channel and bus EQ parameters. It shall also have 16 buttons dedicated to choosing any of the 16 Aux buses. It shall also have two dedicated knobs for adjusting the Preamp Gain and High Pass Filter Frequency. It shall also have a Help button. This button shall be used to access built-in educational and instructional data for the system's main features. This button shall be context sensitive, allowing direct access to instructional text for most parameters using that parameter's button.

c. The mixing control surface shall have 3 Ethernet ports. Two of the Ethernet ports, A and B, can be connected, using Cat5e or Cat6 cables, to stage units supporting 8 inputs and 8 outputs, 16 inputs and 8 outputs, 8 inputs and 16 outputs, or up to 40 inputs and 40 outputs each. Using a gigabit switch, both of the cables can be split to support up to 40 output audio paths. The A and B ports shall support up to 40 output choices from any channel, bus or matrix. The third Ethernet port shall be a duplicate of the A port output assignments.

d. The mixing control surface shall be able to mix up to 48 channels of audio to 16 Aux buses, 8 Matrices and the LCR Main bus. The audio path from each channel shall be selectable from the pre phase, pre EQ, pre fader and post fader positions. Each channel shall have a selectable Delay setting. The mixer shall also provide 8 Matrices that accept inputs from all channels and buses. The sends to the Matrices shall be selectable from pre EQ, prefader and post fader positions.

e. The mixing control surface shall have 8 XLR mic/line inputs, 8 XLR line level outputs and stereo inputs and stereo digital outputs. The control surface shall provide up to 8 external insert paths, available from any channel, bus or matrix;

using the surface's XLR inputs and outputs. The mixing control surface shall provide 5 bands of adjustable equalization on each of the 48 channels along with 48 gates and 48 compressors. It shall also provide a delay setting, 4 bands of equalization and a limiter on each of the 16 Aux buses, 8 Matrixes and the Main LCR bus. The mixing control surface shall include libraries for storing various channel, bus and system parameters. These libraries shall include a Channel library, Patchbay library, EQ library, and Gate and Compressor libraries. Each of these shall have at least 100 user storage patches. The mixing control surface shall provide 6 stereo digital effects processors each of which can also be configured as a dual mono processor. These processors shall be assignable to any channel, bus or matrix as an insert or as loop effects using one of the 6 stereo return channels or Aux buses. In addition it shall provide 12 31- band graphic equalizers assignable to any of the buses or matrices.

f. The mixing control surface shall include 300 scenes that store all of the channel, bus and processing parameters. It shall also provide 16 user buttons that can be assigned to direct scene recall, the tempo parameter for a processor configured as a digital delay, and other parameters. The mixing control surface shall also include an XLR input with phantom power to be used for a talkback microphone. The talkback microphone input shall be assignable to any or all Buses or Matrices. There shall also be an onboard tunable Oscillator and Noise Generator assignable to any Buses or Matrices. It shall also have a large, color, dimmable backlit 800x480 TFT screen. It shall also provide a connector designed for an optional console light.

g. The mixing control surface shall also have a USB slot that will support a USB storage key. The system shall support direct 16-bit, linear wav file recording or playback via this USB key connected to this port. The USB key shall also be used as storage for console parameters including all libraries and scenes. The mixing control surface shall also support the creation of an Administrator password and an unlimited number of individual user profiles which shall be stored to, and require the use of, a USB key for access. The Administrator shall be able to restrict any user from accessing certain or all faders, and a range of mixing system parameters. Each user shall also have their own assignment for the 16 User buttons and the 3 layers of 24 User faders. These faders shall be accessible from the User Fader bank buttons.

h. The mixing control surface shall provide 8 mute groups and 8 DCA groups. The DCA groups shall provide level control from one DCA master fader of a user-assignable collection of channels and buses. The mixing control system shall provide a balanced headphone output. This output shall be assigned to the Monitor bus, which shall also be available as an output to any physical outputs in the system. The headphone output shall have an individually adjustable output level control. The mixing control surface shall also provide meter screens showing channel and bus levels. The channel levels shall be selectable with choices including post preamp, post attenuator, pre fader and post fader. Each fader shall also have a companion LED meter ladder that displays that channel's levels.

i. The mixing control surface shall have a USB port that, when connected to a computer loaded with control software, can be used to control the channel, bus, effects and other parameters of the whole mixing system.

j. Processing

1) Mixing Channels

1. INPUT: 48 channels, 6 stereo returns

2. BUS: MAIN L/C/R, 16 AUX, 8 MATRIX
3. OUTPUT: 10 ports (Max 90 ports When using REAC devices)

2) AD/DA Conversion
1. 24-bit/48.0 kHz or 44.1 kHz

k. Network Latency
1. 2.8 mS (typ.)
2. Total System Latency of audio signal from S-1608 inputs to outputs via M-480's REAC ports (A or B).
3. Sample Rate: 48.0 kHz Effects : No insert effects (0dBu=0.775Vrms)

l. Connectors
1) CONSOLE INPUT jacks (1 to 8)
1. XLR-3-31 type (balanced, phantom power)
2) TALKBACK MIC IN jack
1. XLR-3-31 type (balanced, phantom power)
3) STEREO IN jacks (L / R)
1. RCA phono type
4) CONSOLE OUTPUT jacks (1 to 8)
1. XLR-3-32 type (balanced)
5) PHONES jack
1. Stereo 1/4 inch phone type
6) DIGITAL OUT jacks Stereo
1. Optical type, Coaxial type
7) REAC Ports
1. RJ-45 EtherCon type
8) USB connectors
1. USB Type A and Type B
9) Remote Controls
1. RS-232C connector: 9-pin D-sub type, MIDI connectors
2. (OUT/THRU, IN): 5-pin DIN type
10) Other Connectors
1. GND Terminal,
2. LAMP connector XLR-4-31 type

m. Input/Output Characteristics
1) Frequency Response
1. CONSOLE OUTPUT jacks (1 to 8): -2 dB / +0 dB (20 k ohms load, +4 dBu,typ.
2. PHONES jack: -3 dB / +0 dB (40 ohms load, 150 mW, typ.)
2) Total Harmonic Distortion + Noise
1. CONSOLE OUTPUT jacks (1 to 8): 0.05 % (+4 dBu, typ.)
2. PHONES jack: 0.05 % (typ., 40 ohms load, 150 mW, typ.)
3) Dynamic Range
1. CONSOLE OUTPUT jacks (1 to 8): 110 dB (typ.)
4) Crosstalk@ 1 kHz

1. CONSOLE INPUT jacks (1 to 8): -80 dB (Pad: ON, Input gain: +10 dBu,typ.)
2. CONSOLE OUTPUT jacks (1 to 8): -100 dB (typ.)

5) Nominal Input Level (Variable)
   1. CONSOLE INPUT jacks (1 to 8): -65 to -10 dBu (Pad: OFF) or -45m to +10 dBu (Pad: ON), (typ.)
   2. STEREO IN jacks (L / R): -18 to 0 dBu
   3. TALKBACK MIC IN jack: -50 to -10 dBu
6) Input Impedance
   1. CONSOLE INPUT jacks (1 to 8): 14 k ohms
   2. STEREO IN jacks (L /R): 10 k ohms
   3. TALKBACK MIC IN jack: 41 K ohms
7) Non Clip Maximum Input level
   1. CONSOLE INPUT jacks (1 to 8): +8 dBu (Pad: OFF) or +28 dBu (Pad: ON),(typ.)
   2. STEREO IN jacks (L / R): +18 dBu (typ.)
   3. TALKBACK MIC IN jack: +8 dBu (typ.)
8) Nominal Output Level
   1. CONSOLE OUTPUT jacks (1 to 8): +4 dBu (Load impedance: 10 k ohms, typ.)
9) Output Impedance
   1. CONSOLE OUTPUT jacks (1 to 8): 600 ohms
   2. PHONES jack: 100 ohms
10) Recommended Load Impedance
   1. CONSOLE OUTPUT jacks (1 to 8): 10 k ohms or greater
   2. PHONES jack: 8 ohms or greater
11) Non Clip Maximum Output level
   1. CONSOLE OUTPUT jacks (1 to 8): +22 dBu (1 kHz, 10 k ohms load, typ.)
   2. PHONES jack: 150 mW + 150 mW (1 kHz, 40 ohms load, typ.)
12) Residual Noise Level (IHF-A, typ.)
   1. -88 dBu (All faders: Min)
   2. Equivalent Input Noise Level (E.I.N.) : -126 dBu

n. Others
1) Display
   1. 800 x 480 dots Wide VGA backlit TFT color screen
2) Power Supply
   1. AC 115 V, AC 117 V, AC 220 V, AC 230 V, AC 240 V (50/60 Hz)
3) Power Consumption
   1. 95 W
4) Dimensions
   1. 749.0 (W) x 614.0 (D) x 229.0 (H) mm
   2. 29-1/2(W) x 24-11/16(D) x 9-1/16(H) inches
5) Weight

1. 20 kg, 44 lbs. 1 oz.

o. 48 Channel sound board is Roland M-480, Yamaha LS9-32 with Mini-YGDAI card or equal by Behringer. Provide preamps and mini-cards as needed to provide 64 channels of input.

2. Digital Snake at Control Booth

a. The digital audio transmission system (Digital Snake) shall consist of a Front-of-House (FOH) Module with 16 XLR outputs and 8 XLR inputs. The transmission cable between the Stage Module and the FOH Module shall be a Cat5e or Cat6 cable. Provide cables in length and quantities required.

b. The inputs shall be of very high quality and accept both line and microphone level inputs with individually selectable phantom power. The input gains or trims for the inputs as well as their individually selectable phantom power settings shall be remotely controllable from the Stage or FOH Module using either a hardware remote control unit or a computer. The gain level shall be controllable in 1 dB steps from microphone level to line level. The system shall also offer at least 10 preset memories of different configurations of the input gain and phantom power settings.

c. The audio protocol shall have a 96 kHz sampling rate, deliver 24-bit audio, and have a protocol latency of 375 microseconds from the stage unit to the FOH unit. The Input Module shall allow the user to duplicate or “split” the input sources to several Output Modules using a fast gigabit Ethernet switching hub.

d. Number of Channels

1) 8 Inputs

2) 16 Outputs

3) AD and DA Conversion24 bit / 96 kHz (auto-switchable to 44.1kHz & 48kHz)

e. Frequency Response

1) -2 dB / +0 dB (@ +4 dBu, 20 Hz to 20 kHz)

f. Total Harmonic Distortion + Noise

1) 0.05 % or less (Pad: On, Input Gain: +4 dBu, 22Hz to 20 kHz)

g. Dynamic Range

1) 110 dB

h. Cross Talk

1) -80 dB or less (Input Gain: +4 dBu, typ.)

i. Nominal Input Level

1) -65 to -10 dBu (PAD: Off), -45 to +10 dBu (PAD: On)

2) (1 dB step, Max. +28 dBu)

j. PAD

1) 20 dB On/Off

k. Input Impedance

1) 14 k ohms

l. Nominal Output Level

1) +4 dBu, Max. +22 dBu

m. Output Impedance

1) 600 ohms

n. Recommended Load Impedance

1) 10 k ohms or greater

o. Residual Noise Level (IHF-A, typ.)
   1) -80 dBu or less
p. Equivalent Input Noise Level
   1) S-1608: -128 dB S-0816: -124dB
q. Network Latency
   1) 375 microseconds when using REAC cable only (1)
   2) (AD>REAC>DA Latency: approx 1.2 ms)
r. Connectors
   1) Analog Input x 8 (XLR type, balanced, phantom power)
   2) Analog Output x 16 (XLR type, balanced)
   3) Digital Output connector x 1 (Optical type)
   4) REAC Connector x 1 (RJ-45 EtherCon type)
   5) Remote Connector x 1 (RS-232C, DB-9 type)
s. Indicators
   1) POWER Indicator x 1, REAC Indicator x 1,
   2) REMOTE Indicator x 1, MUTE ALL OUTPUTS Indicator x 1
t. Power Supply
   1) AC 115 V, AC 117 V, AC 220 V, AC 230 V, AC 240 V (50/60 Hz)
u. Power Consumption
   1) 45W
v. Phantom Power
   1) +48 V / 14 mA (each input, remote controlled)
w. Dimensions
   1) 401 (W) x 135 (D) x 177 (H) mm or
   2) 15-13/16 (W) x 5-3/8 (D) x 7 (H) inches
x. Weight
   1) 5.5 kg 12 lbs 3 oz
y. Operation Temperature
   1) 0 to +40 degrees Celsius
   2) +32 to +104 degrees Fahrenheit
z. Accessories
   1) Power Cord x 1, REAC Connector Cover x 1, Ferrite Coresx 1
   2) Rubber Foot x 4, Rack Mount Kit x 1, Owner's Manual
aa. Digital Snake is Roland S-0816, Yamaha Stagebox SB168-ES or equal by Behringer.

3. Digital Snake at Stage (Provide 2)
   a. The digital audio transmission system (Digital Snake) shall be a modular system that can be configured in groups of 8 channels up to a maximum of 40 channels per transmission cable. The system shall consist of one Input or Stage Box Module, with XLR or AES/EBU inputs, as well as the option for multiple line-level “returns” or Outputs. It will also consist of at least one Output or Front-of-House (FOH) Module that will have line level outputs as well as the option for some line level inputs or returns.
   b. The modularity shall allow for different configurations of the Input Module or Stage Box including 40 inputs and 0 outputs, 32 inputs and 8 outputs, or 24

inputs and 16 outputs. The transmission cable between the Input or Stage Box Module and the Output or FOH Module(s) shall be a Cat5e or Cat6 cable. Provide cables in length and quantities required.

c. The inputs shall be of very high quality and accept both line and microphone level inputs with individually selectable phantom power. The input gains or trims for the inputs as well as their phantom power settings, shall be remotely controllable from the Stage or FOH Module using either a hardware remote control unit or a computer. The gain level shall be controllable in 1 dB steps. The system shall also offer at least 10 preset memories of different configurations of the input gain and phantom power settings.

d. The audio protocol for a 40-channel system shall have a 96 kHz sampling rate, provide 24-bit audio, and have a protocol latency of 375 microseconds from the stage unit to the FOH unit. The system shall have redundant Ethernet ports allowing the connection of two Cat5e or Cat6 cables from the Input unit to the FOH unit. The system shall be designed to switch automatically from one cable to the other in the case of damage to one of the cables. The system shall allow the user to copy or “split” the input sources to several Output Modules using a fast gigabit Ethernet switching hub.

e. Number of Channels
   1) 32 in 8 out

f. AD Conversion
   1) Sample Rate: 96.0 kHz
   2) Signal Processing: 24 bit

g. DA Conversion
   1) Sample Rate: 96.0 kHz
   2) Signal Processing: 24 bit

h. Frequency Response
   1) -2 dB / +0 dB (@ +4 dBu, 20 Hz to 20 kHz)

i. Total Harmonic Distortion + Noise
   1) 0.05 % or less (Pad: On, Input Gain: +4 dBu, 22 to 20000 Hz)

j. Dynamic Range
   1) 110 dB

k. Cross Talk
   1) -80 dB

l. Nominal Input Level
   1) -65 to -10 dBu (PAD: Off) -45 to +10 dBu (PAD: On) (1 dB step, Max. +28 dBu)

m. PAD
   1) 20 dB On/Off

n. Input Impedance
   1) 20 k ohms

o. Nominal Output Level
   1) +4 dBu, Max. +22 dBu

p. Output Impedance
   1) 150 ohms

q. Recommended Load Impedance

1) 10 k ohms or greater

r. Residual Noise Level (IHF-A, typ.)
   1) -90 dBu

s. Equivalent Input Noise Level (E.I.N.)
   1) -128 dB

t. Network Latency
   1) 375 microseconds when using REAC cable only
   2) (AD - REAC - DA Latency: about 1.2 ms)

u. Connectors
   1) Input: 32 (XLR type, balanced, phantom power, 4 ch input module x 8)
   2) Output: 8 (XLR type, balanced, 4 ch output module x 2)
   3) REAC: MAIN, BACKUP (RJ-45 EtherCon type)
   4) Remote Connector: 1 (RS-232C, DB-9 type)
   5) MIDI Connectors: IN, OUT (5-pin DIN type)

v. Indicator
   1) EXT Indicator (External Power Supply Unit)
   2) INT Indicator
   3) REAC Indicator
   4) CTRL Indicator
   5) ALARM Indicator
   6) MUTE ALL OUTPUTS Indicator

w. AC Power Supply
   1) AC 115 V, AC 117 V, AC 220 V, AC 230 V, AC 240 V (50/60 Hz)

x. Current Draw
   1) 6A

y. Power Consumption
   1) 130 W

z. Phantom Power
   1) +48 V / 14 mA

aa. Dimensions
   1) 482.0 (W) x 336.0 (D) x 266.4 (H) mm
   2) 19 (W) x 13-1/4 (D) x 10-1/2 (H) inches

bb. Weight
   1) 17.0 kg, 37 lbs 8 oz

cc. Operation Temperature
   1) 0 to +40 degrees Celsius +32 to +104 degrees Fahrenheit

dd. Current Draw
   1) 6 A

ee. Accessories
   1) Power Cord, REAC cable (10 m, Cat5e crossover cable)
   2) Adhesive-backed number label sheets, REAC Connector Covers
   3) Ferrite Cores, Owner's Manual
   4) Digital Snake is Roland S-0816, Yamaha Stagebox SB168-ES or equal.

ff. Digital Snake at Stage is 4000S-3208, Yamaha Stagebox SB168-ES or equal.

4. Microphone Splitter
   a. Provides mic level splitting circuitry in a single rack space unit at mic rack and at control booth and center of house for 'auto mic' connections as noted on drawings.
   b. Depth is 7.5" including tie bar.
   c. Provides one direct and one transformer isolated output per channel using Jensen transformer.
   d. All connections are made via removable Phoenix style connectors included with the unit.
   e. Microphone Splitter to be Whirlwind SPC82JT or equal by Galaxy or Rolls. Provide quantity as needed for design intent. Install in stage mic rack.

5. Speakers, Line Array
   a. Front of House (FOH) Speakers:
      1) Bose Design (or equal by JBL or EAW)
         1. Line Arrays
            a. Two (2) line arrays, Left and Right of stage
               1) Left top to bottom: RM452810, RM602810, RM602820
               2) Right top to bottom: RM284510, RM286010, RM286020
            b. Two (2) RMSHAD, install in top of array modules
            c. Two (2) RMAFLG array frames
            d. Flown from ceiling. All components, color shall be black.
         2. Subwoofers
            a. Two MB24 WR sub-woofers flown from ceiling, center stage area. Color: Black.
         3. Delay Speakers – Three (3) RMU206. Color: Black
   b. Stage Floor Monitor Speakers:
      1) Quantities: 4 total (two stage right, two stage left).
      2) Description:
         Frequency response +/- 3dB: 70Hz to 16 kHz.
         Pressure sensitivity: 90 dB @ 1m
         Coverage (conical): 45 degree position:40 degrees H x 120 degree V.
         Power capacity:
            200 watts.
         Maximum passive SPL: 113 dB @ 1m; 119dB peak.
         Nominal impedance: 8 ohms.
         Color: Black
      3) Speakers shall not be mounted, and will not be used for every event.
      4) Speakers by Eastern Acoustic Works (EAW), Model SM155e, or Bose RMU108 or JBL Model EON 612.

   c. Control Booth Monitor Speakers:
      1) Quantity: 2 required

2) Description:

Type: 2-way, ported enclosure.

Frequency response: 75Hz to 18 kHz.

Pressure sensitivity: 85 dB @ 1m.

Coverage: 180 degrees x 75 degrees.

Power capacity: 100 watts.

Nominal impedance: 8 ohms.

Mounting: Built-in, wall, rotatable.

3) Wall Mount speakers to left and right in control room.

4) Speakers (2) are EAW, UB12SE with mounts, Bose DS100SE or JBL.

d. Ceiling Mounted Speakers with local volume control (Practice rooms at SPr locations): 163A, 163B

1) Owner to provide two speakers. Speakers shall be connected to the master sound mixing console aux bus to provide house program sound reinforcement to the backstage practice/changing rooms. Speakers shall be installed by 274000 subcontractor to provide even sound coverage in the room.

2) Provide and install a wall mounted local volume control for each room.

e. Amplifiers: Qty 4 min

1) Provide amplifiers sized as necessary to provide 95-100 dbSPL to the audience area with even coverage based on specific speaker selection.

2) Mount all amplifiers in equipment rack in control room except for one amplifier in stage rack for stage monitor speakers, control room speakers and two practice rooms. See T2.8.

3) Provide amplifiers for the following channels per design:

Arrays/Subs/Delays: Three (3) PM8500N each with PM ESPlink card

a. Arrays (3 speakers per array, 2 arrays, (6 speakers total)): 2 channels bridged per speaker in each array. See T2.8

b. Subwoofers: 4 channels, bridged, per subwoofer (2 subwoofers total) See T2.8

c. Delays: 1 channel per speaker (3 delay speakers total). See T2.8.

2. Stage Monitors (4), Practice Rooms (2) and Control Booth Wall Speakers (2): One (1) PM8250N with PM ESPlink card

a. Stage Monitors (4), practice rooms (2) and control booth (2 speakers): 1 channel per speaker. See T2.8.

3. ESP1240 sound processor with Etherlink card

4. Four (4) Powermatch ESP Link cards required

5. ControlSpace CC-64

6. ControlSpace CC-PS1 power supply

4) Provide and install all switching equipment required for design, in the port densities required.

5) Amplifiers are by Bose, Crown International, CT Series, Crest, Hafler or equal.

6. Digital Signal Processor (Minimum 2)

f. Provides a configuration of 12 inputs and 8 outputs, configurable signal processing and a high bandwidth, fault tolerant digital audio bus. Include inputs

and outputs for rack mounted jacks listed in item 23 EQUIPMENT RACKS below.

g. It has open architecture which is fully configurable through HiQnet™ London Architect. A rich palette of processing and logic objects and a “drag and drop” method of configuration provide a simple and familiar design environment.

h. The processor features a low latency, fault tolerant digital audio bus of 48 channels which uses standard Category 5e cabling giving a distance of 100m between compatible devices. Fiber media converters can be used to increase the distance between devices to over 40km.

i. Analog Inputs provide software configurable gain in 6dB steps up to +48dB per channel and software selectable Phantom Power per channel.

j. Phantom Power, Signal Present and Clip information per channel is easily accessible, without the requirement for a PC, from clear front panel LED indication. A bi-directional locate function allows devices to be identified both from and within HiQnet London Architect.

k. 12 Control Inputs and 6 Logic Outputs intergrates with GPIO compatible devices.

l. Key Features:

1) 12 Analog Inputs (with 48v Phantom Power per Channel)
2) 8 Analog Outputs
3) Configurable Signal Processing
4) Rich Palette of Processing and Logic Objects
5) 48 Channel, Low Latency, Fault Tolerant Digital Audio Bus
6) Clear Front Panel LED Indication
7) Bi-Directional Locate Functionality
8) 12 Control Inputs and 6 Logic Outputs for GPIO integration
9) configuration, Control and Monitoring from
10) Technical Specifications:

Front Panel Led Indicators:

Per Input: Signal Present, CLIP, 48V (Input only)

Other: COM, STAT, ERR, PWR

Analog Inputs: 12 electronically balanced on Phoenix Combicon removable screw connectors

Mic/Line Inputs:

Nominal gain 0dB, electronically switchable up to +48dB,in +6dB steps

Input Impedance:

3.5kΩ

Maximum Input Level:

+20dBu with 0dB input gain,+8dBu with 12dB gain

CMRR:

>75dB at 1KHz

Input Noise (E.I.N.):

<-128dBu typical with 150Ω source

Phantom Power:

48V nominal, selectable per input

A/D Latency:

37/Fs [0.77ms@48k]

Analog Outputs: 8 electronically balanced on Phoenix/Combicon removable screw connectors

Maximum Output Level:

+19dBu

Frequency Response:

20Hz-20KHz (+0.5dB/-1dB)

THD:

<0.01% 20Hz to 20KHz, +10dBu output

Dynamic Range:

108dB typical, 22Hz-22KHz unweighted

Crosstalk:

<-75dB

Output Impedance:

40Ω balanced and 20 Ω unbalanced

D/A Latency:

29/Fs [0.60ms@48k]

Control Ports: 12 inputs and 6 outputs

Control Input Voltage:

0 to 4.5v

Control Input Impedance:

4.7kÙ to +5V (2-wire mode), >1MÙ (3-wire mode)

Logic Output Voltage:

0 or +5V unloaded

Logic Output Impedance:

440 Ω

Logic Output Current:

10mA source, 60mA sink

Watchdog Output: Phoenix/Combicon connector for failsafe control

Opto Output Current:

14mA maximum

Withstanding Voltage:

80V maximum (Off)

Series Impedance:

220 Ω (isolated)

Control Network:

Connectors:

RJ45 Ethernet connector

Maximum Cable Length:

100m/300ft on Category 5 cable between device and Ethernet switch

BLU link:

Connectors:

2 x RJ45 Ethernet connectors

Maximum Cable Length:

100m/300ft on Category 5e cable between devices

Max. Number of Nodes:

60

Latency:

11/Fs [0.23ms@48k]

Pass Through Latency:

4/Fs [0.08ms@48k]

Power and Dimensions:

Mains Voltage:

100-240V AC, 50/60Hz

Power Consumption:

<55VA

BTU Rating:

<188 BTU/hr

Operating Temp. Range:

5 (41) to 35 (95) degrees C (degrees F)

Dims:

(H(U) x W x D): 1.75" (1U) x 19" x 9.0" (45mm x 483mm x 229mm)

Weight:

6.4 lbs / 2.9 Kgs

m. Digital Signal Processor shall be the BSS Audio BLU-100 and BLU-BOB2 and/or BLU-BIB as necessary or equal by Soundweb or Biamp Audia Flex. DSPs shall be used for auto mic function. Provide in quantities needed to accomplish auto-mic total as noted on drawings and design intent.

7. Assistive Listening System
   a. The stationary FM transmitter shall be capable of broadcasting on 57 channels.
   b. The transmitter shall have a SNR of 80dB or greater.
   c. The output power shall be adjustable to quarter, half or full.
   d. Channel tuning shall be capable of being locked.
   e. The device shall broadcast on both wide and narrow band channels.
   f. The device shall have an audio frequency response of 50Hz to 15KHz, +/- 3dB at 72MHz, or of 50Hz to 10kHz, +/- 3dB at 216MHz.
   g. It shall have two mixing audio inputs. The device shall have the following audio controls: input level, process control and an adjustable low pass shelving filter.
   h. Provide appropriate antenna, and rack mounting kit. Mount in booth rack.
   i. Provide 5 programmable receivers (Listen Technologies LR-500 or equal) with ear buds and rechargeable batteries, and five transformer/wall chargers.
   j. The Assistive Listening System is the Listen LT-800, or Phonic Ear, Williams Sound or equal.
8. CD iPod Dock Combination Unit
   a. Plays audio CDs, MP3 CDs and WAV file CDs
   b. Provide output terminals for both RCA and XLR connections
   c. Dock connector for Apple iPod charging and playback

d. iPod video playback from S-video or composite output
e. CD TEXT and ID3 tag support
f. Continue, Random and Program play modes
g. Repeat All and Repeat Single play modes
h. Unit MUST have Auto-Cue capability
i. Index Search
j. Shock/skip prevention memory buffer
k. ±12% pitch control (analog outputs only)
l. RCA unbalanced line outputs (CD and iPod)
m. Coaxial and Optical S/PDIF digital out (CD only)
n. 1/4" stereo headphone output
o. 2u rack mountable
p. Wireless 55-key remote control
q. 19"W x 3.72" H x 11.73"D
r. Install in COH Roll top desk rack at the top of one of the lower rack units

CD/ iPod dock is a Tascam CD-200i Pro or equal by Denon or Marantz.

9. Solid State Recorder (IF REQUIRED; function can be part of sound board)
   a. Record Directly to Compact Flash Cards.
   b. S-232c Control of Functions
   c. Easy One Touch Record
   d. No Moving parts
   e. MP3, MP2, WAV and BWF format compatible
   f. The unit shall offer a door for security
   g. Unit shall be mounted in the 19” rack contained in the roll top desk by the audio mixing panel.
   h. One unit shall be connected to the VCA Mixer as a recording device.
   i. The recorder shall be mounted in a 19” rack in the COH roll top desk.

   Solid State Recorder unit is the Marantz PMD580 or equal by Tascam or Denon.

10. Single CD/MP3 Player
   a. The CD player shall be housed in a single 2RU rack-mount chassis.
   b. The unit shall provide an FL tube display and support CD text. The unit shall provide CD frame indication.
   c. The unit shall provide a user adjustable preset menu.
   d. The CD player shall offer a Single/Continuous mode and provide pitch control of ±12%.
   e. The unit shall support CD-RW discs.
   f. The unit shall provide auto cue to music, instant start and support MP3 playback.
   g. The digital servo shall feature an automated adjustment and the CD player shall provide shock proof memory.
   h. The unit shall feature an 11-key keypad for direct track entry, and shall feature a headphone jack mounted on the front panel.
   i. The unit shall provide cascade and sync ports for use with other DN-C615 units. The unit shall provide a coaxial SPDIF digital output jack.
   j. The unit shall provide an IR sensor mounted behind the front panel display.
   k. Unit shall be mounted in the 19” rack contained in the roll top desk.
   l. CD player is by Denon or equal by Marantz or Tascam.

11. Video Camera System

a. Provide three local monitors (5" color) for display of each camera's video source. Install monitors in Control Room on counter top.
b. Video Camera System is Sony EVI-H100S or equal by Panasonic or Canon (provide three cameras, one at each V1 location in auditorium) with Marshall Electronics V-MD503-3GSDI or equal (mount displays on control booth counter top below window not in eq rack). Provide joystick and joystick control for these PTZ cameras.
c. Provide C2-2100 down converter(s) to send HD camera feeds to touch panel at center of house. Touch panel at center of house shall be programmed to select a PTZ camera and adjust the PTZ of that camera. Provide joystick control at COH if required for this function as well as in control booth. Wire composite output of down converter to touch panel at center of house roll top desk.

12. Wireless Microphone Systems (Provide 5)
    a. Power On Indicator
    b. "RF" Diversity Signal Indicators
    c. Transmitted (TX) Audio Indicators
    d. Receiving Antenna Indicator
    e. Group/Channel Displays
    f. Transmitter Battery Life Indicator
    g. MODE Button for Menu Display
    h. SET Button for Saving Settings
    i. Mic/Line level Switch
    j. XLR and ¼" outputs with level control
    k. Provide rack mounting kit, and mount in equipment cabinet.
    l. Per system, provide 1 handheld microphone, one head worn microphone/transmitter, and one lapel microphone/transmitter combination on the same frequency.
    m. Install receivers in audio system cabinet (center house mixing console) 19" equipment rack. Provide necessary remote antennas to ensure a clear signal. Provide and install recess mount brackets such that the front connections will not interfere with the rack door of the desk.
    n. Provide antenna distribution amplifier to reduce number of antennae's required. Mount antennas at stage/house area. Provide required distribution to avoid mounting antennas at CoH. Place and provide number of antennas to provide full stage and auditorium coverage.
    o. Two of the wireless microphone system shall be split and be "Auto-Mics". Label accordingly.
    p. Model is the Shure ULXS, with Rack Mounting Kit or equal by Electro-Voice or Sennheiser.

13. Video Projector with Mount
    a. A minimum 10,500 ANSI lumens video projector with long throw lens (must fully fit screen).
    b. Vertical and horizontal lens shift and digital keystone correction shall provide picture-perfect placement of image.
    c. Input compatibility ranges from analog and digital RGB data up to UXGA resolution and video sources from composite through 1080i HDTV.
    d. Intelligent lens system

e. Specifications
   1) Brightness, 10,500 lumens min
   2) Contrast Ratio: 2500-10,000:1 full on/off; 650:1 ANSI (typ)
   3) Resolution: Native WUXGA 1920 x 1200, 3 chip DLP
   4) 90% brightness uniformity
   5) Dynamic Scaling: Digital scaling of resolutions Digital De-interlacing Technology of STV, DTV, and HDTV formats (DDT) with 2:3 pull-down
   6) Horizontal Frequency: 15 to 120kHz
   7) Vertical Frequency: 24 to 150Hz
   8) Pixel Clock: 165MHz
   9) Projection Lens: Provide long-fixed lens sized to fit projection screen listed in Division 11.
   10) Digital keystone correction
   11) Accepts all current HDTV/DTV formats (VGA to QXGA)
   12) Auto-Setup
   13) Comprehensive color adjustment
   14) Multi-standard video decoder
   15) Horizontal and vertical scaling all inputs
   16) Offsets: +/- 112% vertical; +/- 54% horizontal
   17) Modular Inputs required:
      Dual link DVI
      Twin HDMI
      Analog
      Ethernet / LAN (provide and install patch cord to data jack at projector location)
      RS-232
      Other inputs needed for submitted design
   18) Outputs:
      Two built-in speakers
      Stereo audio loop-through
f. Provide ceiling mount and place in Control Room. Adjust image to fit the Auditorium screen.
g. Projector model is Christie WU12K-M WUXGA DLP projector with long throw lens or equal by Infocus or Mitsubishi.

14. Blue Ray Player. Install in booth rack.
   a. Supports Super Audio CD and DVD-Audio formats
   b. Support Blu-ray 3DTM playback(1)
   c. Network functions, capable of playing YouTube and Netflix video distribution services without a PC, music, photo, and video files stored on a network-connected device such as a PC or NAS.
   d. Support Deep Color, “x.v.Color”, High-Bit-Rate Audio output and HDMI control function
   e. High quality 32-bit/192kHz audio digital to analog converters
   f. High quality 12-bit video digital to analog converter
   g. USB port on the front

h. Direct Mechanical Ground Construction, to suppress vibration and ensure high-quality HD sound and video
i. Independent Block Construction, for faithful playback of audio and video signals
j. Advanced High-bit I/P Scaler, for a more detailed picture and depth in colors
k. 1080p/24 video output, to bring out the full quality of film
l. Deep color support
m. 3-D digital noise reduction
n. HDMI source direct mode to output native resolution of the disc
o. Picture adjustments
p. Gold plated terminals
q. User friendly GUI
r. Glo-key remote controller
s. AMX, Crestron third party control support via RS-232C Custom Integration
t. Remote In/Out connection
u. Remote lock mode
v. Supports Super Audio CD and DVD-Audio formats
w. Support Blu-ray 3DTM playback
x. Dolby TrueHD and DTS-HD Master Audio HDMI output
y. Advanced High-bit I/P Scaler
z. 1080p/24 video output
aa. Supports Super Audio CD and DVD-Audio formats.
bb. Supports Blu-ray discs, DVDs, CDs, Super Audio CDs, and DVD-Audio.
cc. Plays compressed content such as music and video files. Supports DivX® video files stored on USB memory, DVD-R/RW or other recordable media, MP3 and WMA music files, JPEG files taken with a digital camera, as well as WMV video files and MPEG-AAC music files.
dd. Versatile Disc Formats Playability
    1) BD-Video
    2) BD-R (BDMV format)
    3) BD-RE (BDMV format)
    4) DVD-Video
    5) DVD-Audio
    6) DVD+R, DVD+RW (Video mode, AVCHD format)
    7) DVD-R, DVD-RW (Video mode, AVCHD format)
    8) Super Audio CD
    9) Audio CD
    10) CD-R, CD-RW
    11) Kodak Picture CD
ee. Other Features
    1) HDMI resolution select on front panel
    2) Detachable AC cord
ff. Ports
    1) Video

HDMI output x 1
Component output x 1
Composite output x 1

2) Audio
Coaxial digital output x 1
Analog output (2ch, L/R) x 1
Analog output (7.1ch audio out) x 1

3) Control
Ethernet x 1
USB port x 1
RS-232Cx 1
Remote control (IN / OUT) x 1 / x 1

gg. Main Specifications

1) Video
Signal system
PAL/NTSC

2) Audio
S/N
125 dB
Total harmonic distortion
0.0008% (2ch, L/R)
Dynamic range
110 dB

3) General
Power supply
110 - 240 V, 50/60 Hz

4) Dimensions
W x H x D 434 x 107 x 319 mm (incl. protrusions)

5) Weight
5.2 kg

hh. Blue Ray player is Denon BDP-2012UD or equal by Marantz or Tascam

15. Microprocessor controlled Fully Digital Matrix Video Switcher (NOTE: switcher must be provided with additional inputs and outputs to provide the connectivity at the rack as stated in item 23. EQUIPMENT RACKS below)

a. SUMMARY

1) The HD Digital Transport and Distribution System shall include providing and integrating the following principal systems:
Audio/Video switching.
Audio/Video distribution at native resolution without compression.
Video interface equipment.
Audio interface equipment.
HDMI signal transport.
HDCP support.
Deep Color support.

EDID management.

HDCP KSV handling/management.

Digital diagnostic tools.

b. The AV switching system shall support at least 6.75Gbps of data transfer on each input and output to support 1080p 36-bit (Deep) Color video resolutions without compression.

c. The AV switching system shall support 8 channel audio.

d. The AV switching system shall support audio breakaway from video.

e. The AV switching system shall support the HDMI specification of less than 1 in 1x10-9 bit errors at 1080p 36-bit (Deep) Color.

f. The AV switching system shall downmix multi-channel audio into 2-channel audio so that the same audio content may be routed to both multi-channel and 2-channel sinks.

g. The AV switching system shall be able to dither between standard and deep color video signals on each input and output.

h. The AV switching system shall support the following AV signal inputs:
   1) HDMI 1.3a (High Definition MultiMedia Interface)
   2) DVI 1.1 (Digital Visual Interface)
   3) DisplayPort Multimode 1.1
   4) Analog RGB
   5) YPbPr
   6) S-Video
   7) CVBS
   8) SPDIF
   9) Analog Stereo Audio
   10) SDI

i. The AV switching system shall transcode the AV signals to a single signal type for distribution.

j. The AV distribution system shall route AV signals from any input to any output with less than 1ms of latency.

k. The AV distribution system shall not require extra cabling to transmit the following control signals for AV sources and sinks:
   1) RS-232
   2) Infrared
   3) Ethernet
   4) USB Human Interface Device-class devices
   5) Contact closure

l. EDID MANAGEMENT
   1) The AV switching system shall allow configuration of the EDID presented to sources on each AV input.
   2) Each input on the AV switching system shall be configured independently.
   3) The AV switching system shall by default present an EDID to each input that includes only the video timings and audio formats common all sinks connected to the outputs.
   4) The AV switching system shall allow the user to enter each input's EDID video timings individually.

5) The AV switching system shall allow the user to enable and disable support for the following items in each input's EDID.

   Deep color

   3D support

m. HDCP MANAGEMENT

1) The AV switching system shall support HDCP 1.1 or greater.
2) The AV switching system shall detect the number of KSVs supported by each source.
3) The AV switching system shall not send a source more KSVs than it supports.
4) The AV switching system shall cache the KSVs from each connected sink.
5) The AV switching system shall authenticate all cached KSVs with each source up to the source's KSV limit, so that authentication does not need to be re-started each time content is routed to a new output.

n. SIGNAL DETECTION

1) The AV switching system shall report the following incoming signal information to an AV control system:

   Signal detect

   Horizontal and vertical resolution

   Signal refresh rate

   Presence of HDCP

o. The AV switching system shall report the following information to an AV control system:

   HDCP authentication status for each source and sink

   EDID Preferred video timing for each sink

   Maximum number of KSVs supported by each source

p. TROUBLESHOOTING

1) The AV switching system shall report the following information for troubleshooting:
2) Maximum number of KSVs supported by each source
3) The number of KSVs sent to each source
4) EDID indicated Video timings and audio formats supported for each sink
5) EDID presented to each source
6) The AV switching system shall support off-site remote troubleshooting via Ethernet

q. SYSTEM DESIGN

1) The communications subcontractor shall provide AV source equipment with support for enough KSVs so that it can be routed to all sinks simultaneously.
2) If a particular AV source cannot be found to support enough KSVs to route to all sinks simultaneously, the communications subcontractor shall:

   Notify the Engineer

   Configure the AV switching equipment so that it shall not send an AV source more KSVs than it supports.

3) The communications subcontractor shall configure the EDID presented to each AV source to indicate only the video timings supported by ALL sinks

used for viewing and distributing video.

4) The communications subcontractor shall configure the EDID presented to each AV source to indicate support for only the audio formats actually supported by ALL the sinks used for distributing audio.
5) The communications subcontractor shall verify the data rate supported by each shielded twisted pair cable used for AV distribution.
6) The communications subcontractor shall provide display equipment that does not overscan the video signal when full-pixel sources are routed.

r. DEMONSTRATION AND ACCEPTANCE TESTING

1) The demonstration and acceptance tests shall be done by a Crestron DigitalMedia Certified Engineer (DMC-E)
2) The communications subcontractor shall provide a copy of the following information in electronic format in order to verify the AV switching equipment has been installed and configured correctly:
3) The number of HDCP KSVs УKeysФ supported by each source
4) The video timing, HDCP use and audio format of each source when operating (not needed for walk-in equipment)
5) The video timings and supported audio formats for each connected sink
6) The video timings and supported audio formats presented in the EDID to each source – the preferred video timing shall be indicated
7) The length of cable used on all shielded twisted pair cable used for AV distribution
8) The data rate supported by each shielded twisted pair cable used for AV distribution
9) The HDMI Matrix shall consist of a card-cage type unit, capable of accepting different input and output cards.
10) Any input shall be routable to any output. Matrix shall provide almost instantaneous HDMI switching for sources with HDCP. Breakaway audio, video, and USB switching shall also be available.

s. 16x16 Matrix – 16 inputs, 16 outputs

1) The matrix shall meet the following minimum requirements:

Ethernet support.

Gigabit uplink.

Integrated 10/100 managed Ethernet switch.

Sixteen (16) field configurable input card slots.

Four (4) factory configurable output card slots.

Output card accommodates 4 signal outputs.

Easy software setup tool.

Front panel LCD diagnostic screen.

HDCP key register detection.

HDMI Cable test tool.

Automatic resolution management via EDID.

HDCP digital rights key management.

Fast HDMI switching with keep-alive HDCP link.

CEC signal management.

Intercept CEC data being sent from HDMI devices.

Send control information.

2) The matrix shall be a Crestron DM-MD16X16 or equal by Extron or Kramer (Provide 1)

t. HDMI Input Card w/DSP

1) The HDMI input card shall accept an HDMI signal. It shall provide a 2-channel mix of multi-channel audio sources. The original audio track(s) shall also be preserved and passed through to the matrix. This signal shall be available as an output on the matrix.

2) The HDMI input card shall meet the following minimum requirements:

One (1) HDMI input.

19-pin type A female HDMI connector.

Supports HDCP 1.1.

Supports HDMI 1.3 with Deep Color.

One (1) HDMI output.

Buffered output from video input.

Audio consists of either 2-channel mixed audio or original multi-channel audio track.

19-pin type A female HDMI connector.

Supports HDCP 1.1.

Supports HDMI 1.3 with Deep Color.

One (1) USB 1.1 port for USB HID data.

Mouse, keyboard, game controller, or other USB HID device support.

USB Type A female connector.

Audio processor.

HD audio decoder DSP.

Dual 32-bit cores.

Support for various audio/surround formats:

Bypass.

Stereo.

PCM 96/24.

MLP Lossless.

Dolby Pro Logic IIx.

Dolby Digital 5.1.

Dolby Digital EX.

Dolby TrueHD.

DTS Neo:6.

DTS Virtual.

DTS Digital 5.1 Discrete.

DTS ES 6.1 Discrete.

DTS ES 6.1 Matrix.

DTS 96/24.

DTS-HD Master Audio.

Digital to analog converter.

24-bit, 48 KHz

Provide 2-channel mix of either surround audio or 2-channel pass-thru audio on one (1) stereo analog audio output.

Two (2) RCA female connectors.

Unbalanced line-level output.

Provides pass-through signal converted from HDMI input.

Maximum Output Level: 2 Vrms.

Output Impedance: 100 ohms nominal.

Analog shall meet or exceed:

Frequency response: 20Hz to 20kHZ ±0.5dB.

S/N Ratio: >95dB, 20Hz to 20kHz A-weighted;

THD+N: <0.005% @ 1kHz;

Stereo Separation: >90dB

3) The input card shall be a Crestron DMC-HD-DSP or equal by Extron or Kramer. (Provide in quantity for design intent)

u. DVI Input Card

1) The Video Input Card shall accept a DVI video signal, injected audio and convert to HDMI signal. This signal shall be available as an output on the matrix.

2) The HDMI input card shall meet the following minimum requirements:

One (1) DVI input.

One (1) DVI-I female connector.

Auto-sensing multi-format analog video input.

Support for the following video types:

DVI

YPbPr (component).

Y/C (S-Video).

RGB

Support for the following video formats:

NTSC

PAL

Support for the following video resolutions:

480i

480p

576i

576p

720p

1080i

1080p

Video analog to digital converter.

10-bit, 170MHz.

3) One (1) HDMI output.

Buffered output from input.

19-pin type A female HDMI connector.

Pass through of video input signal (matched format/resolution).

Pass through of audio input signal.

4) One (1) analog audio input.

One (1) 5 pin 3.5mm terminal block- detachable.

Pass through to HDMI output.

5) The input card shall be a Crestron DMC-DVI or equal by Extron or Kramer. (Provide in quantity for design intent)

v. 3G-SDI Input Card

1) The Video Input Card shall accept SD-SDI, HD-SDI and 3G-SDI video signal, injected audio and convert to HDMI signal. This signal shall be available as an output on the matrix.

2) The HDMI input card shall meet the following minimum requirements:

One (1) SDI input.

One (1) BNC female connector.

Auto-sensing multi-format analog video input.

Support for the following video types:

SD-SDI (SMPTE 259M)

HD-SDI (SMPTE 292M)

3G-SDI (SMPTE 424M)

Support for the following video resolutions:

SMPTE 425M (3G-SDI) 4:2:2 Colorspace: 1920x1080@50Hz (1080p50), 1920x1080@60Hz (1080p60);

SMPTE 425M (3G-SDI) 4:4:4 Colorspace: 1280x720@50Hz (720p50), 1280x720@60Hz (720p60), 1920x1080@24Hz (1080p24), 1920x1080@25Hz (1080p25), 1920x1080@30Hz (1080p30), 1920x1080@50Hz (1080i50 or 1080sF25), 1920x1080@60Hz (1080i60 or 1080sF30);

SMPTE 260M (HD-SDI): 1920x1035@60Hz (1035i60); SMPTE 295M (HD-SDI): 1920x1080@50Hz (1080i50); SMPTE 274M (HD-SDI): 1920x1080@24Hz (1080p24), 1920x1080@24Hz (1080sF24), 1920x1080@25Hz (1080p25), 1920x1080@30Hz (1080p30), 1920x1080@50Hz (1080i50 or 1080sF25), 1920x1080@60Hz (1080i60 or 1080sF30); SMPTE 296M (HD-SDI): 1280x720@50Hz (720p50), 1280x720@60Hz (720p60);

SMPTE 259M-C (SD-SDI): 720x480@59.94 (NTSC), 720x576@50i (PAL)

One (1) SDI (loop-thru) output

One (1) BNC female connector

Output Resolutions

Matched to Inputs

Video analog to digital converter.

10-bit, 170MHz.

One (1) HDMI output.

Buffered output from input.

19-pin type A female HDMI connector.

Pass through of video input signal (matched format/resolution).

Pass through of audio input signal.

One (1) analog audio input.

One (1) 5 pin 3.5mm terminal block- detachable.

Pass through to HDMI output.

3) The input card shall be a Crestron DMC-SDI or equal by Extron or Kramer. Provide in quantity for design intent.

w. UTP/STP Input Card w/DSP Type 1

1) The UTP/STP-DSP input Card shall accept UTP/STP signal and convert to HDMI signal and separate audio output as full surround and simultaneous two channel down-mix. This signal shall be available as an output on the matrix.

2) The UTP/STP input card shall meet the following minimum requirements:

One (1) UTP/STP input.

Two (2) 8 pin RJ45 UTP/STP connectors, female.

Support for the following video resolutions:

480i
480p
576i
576p
720p
1080i
1080p

Video analog to digital converter.

10-bit, 170MHz.

One (1) HDMI output.

Buffered output from input.

19-pin type A female HDMI connector.

Pass through of video input signal (matched format/resolution).

Support for various audio/surround formats:

Bypass.
Stereo.
PCM 96/24.
MLP Lossless.
Dolby Pro Logic IIx.
Dolby Digital 5.1.
Dolby Digital EX.
Dolby TrueHD.
DTS Neo:6.
DTS Virtual.
DTS Digital 5.1 Discrete.
DTS ES 6.1 Discrete.
DTS ES 6.1 Matix.
DTS 96/24.
DTS-HD Master Audio.

Pass through of audio input signal.

Two channel down-mix

One (1) analog audio input.

Two (2) RCA female connectors.

Pass through to HDMI output.

3) Digital to analog conversion 24 bit 48 kHz

4) The input card shall be a Crestron DMC-CAT-DSP or equal by Extron or Kramer. Provide in quantity for design intent.

x. UTP/STP Input Card w/DSP Type 2

1) The UTP/STP-DSP input Card shall accept UTP/STP signal and convert to HDMI signal and separate audio output as full surround and simultaneous two channel down-mix. This signal shall be available as an output on the matrix.

2) The UTP/STP input card shall meet the following minimum requirements:

One (1) UTP/STP input.

One (1) 8 pin RJ45 UTP/STP connectors, female.

One (1) 8 pin RJ45 POE in connector, female

Support for the following video resolutions:

480i

480p

576i

576p

720p

1080i

1080p

Video analog to digital converter.

10-bit, 170MHz.

One (1) HDMI output.

Buffered output from input.

19-pin type A female HDMI connector.

Pass through of video input signal (matched format/resolution).

Support for various audio/surround formats:

Bypass.

Stereo.

PCM 96/24.

MLP Lossless.

Dolby Pro Logic IIx.

Dolby Digital 5.1.

Dolby Digital EX.

Dolby TrueHD.

DTS Neo:6.

DTS Virtual.

DTS Digital 5.1 Discrete.

DTS ES 6.1 Discrete.

DTS ES 6.1 Matix.

DTS 96/24.

DTS-HD Master Audio.

Pass through of audio input signal.

Two channel down-mix

3) One (1) analog audio input.

Two (2) RCA female connectors.

Pass through to HDMI output.

4) Digital to analog conversion 24 bit 48 kHz

5) The input card shall be a Crestron DMC-C-DSP or equal by Extron or Kramer. (Provide in quantity for design intent.

y. UTP/STP Output Card Type 1 w/ HDMI Connectors. Type 2

1) The UTP/STP Output Card shall provide transmission of any HDMI signal inputted to the matrix.

The Output Card shall provide six (6) discrete outputs.

The Output Card shall interface with two (2) unshielded twisted-pair or shielded twisted pair cable.

The card shall provide HDMI outputs.

Mirrored output of one (1) UTP/STP outputs.

Four (4) 19-pin Type A HDMI female connectors.

2) The Output Card shall be a Crestron DMC-2330 or equal by Extron or Kramer. Provide in quantity for design intent.

z. UTP/STP Output Card Type 2

1) The HDMI output cards shall be compatible with the HDMI Matrix. Output cards shall transmit any input signal. Output cards shall have various arrangements of connector types. Output cards shall have up to four (4) outputs per card. Output card types shall be as follows:

UTP/STP Output Card

The UTP/STP Output Card shall provide transmission of any HDMI signal inputted to the matrix.

The Output Card shall provide two (2) discrete outputs.

The Output Card shall interface with (2) unshielded twisted-pair or shielded twisted pair cable.

2) The Output Card shall be a Crestron DMCO-5000 or equal by Extron or Kramer. Provide in quantity for design intent.

16. Table Digital Transmitters (Provide 1 at V2 at COH)

a. The transmitter shall meet the following minimum requirements:

1) One (1) HDMI input (Video & Audio).

Supports HDMI 1.3 with Deep Color.

Supports HDCP 1.1.

Supports 7.1 channel lossless audio

Supports DVI-D

Supports Display port

2) One(1) RGB input

RGBS

RGsB
RGBHV

3) One (1) analog stereo audio inputs.
(1) 3.5mm TRS (L/R unbalanced).
4) One (1) USB HID port.
Supports USB 1.1.
5) One (1) 10/100 LAN port.
6) One UTP/STP HDMI extended signal output RJ-45 Female.
Signal transmission up to 330 feet on CAT5e or better
7) One (1) power input.
(1) 2.1mm barrel DC power jack.

b. Under Table mountable
c. Table Digital Transmitter is Crestron DM-TX-201-C or equal by Extron or Kramer.

17. Wall Mounted Digital Transmitters (Provide 1 at each V2 at stage apron (qty 3))
a. The transmitter shall meet the following minimum requirements:
1) One (1) HDMI input (Video & Audio).
Supports HDMI 1.3 with Deep Color.
Supports HDCP 1.1.
Supports 7.1 channel lossless audio
Supports DVI-D
Supports Display port
2) One(1) RGB input
RGBS
RGsB
RGBHV
3) One component, one composite, left and right audio RCA inputs.
4) One (1) analog stereo audio input.
(1) 3.5mm TRS (L/R unbalanced).
5) One (1) USB HID port.
Supports USB 1.1.
6) One UTP/STP HDMI extended signal output RJ-45 Female.
Signal transmission up to 330 feet on CAT5e or better
7) One (1) power input.
(1) 4-pin 3.5mm detachable terminal block.
b. Wall mountable on US 3-gang electrical box.
c. Wall Mounted Digital Transmitter is Crestron DM-TX-400-3G or equal by Extron or Kramer

18. Wall Mounted Digital Receivers (E locations at stage, qty 2)
a. The receiver shall accept the HD signal via UTP/STP wire and convert it to one (1) HDMI output. When used with a supported control system, the receiver shall provide local control to device(s The transmitter shall meet the following minimum requirements:

1) One (1) HDMI output (Video & Audio).

Supports HDMI 1.3 with Deep Color.
Supports HDCP 1.1.
Supports 7.1 channel lossless audio.
Supports DVI-D
Supports Display port

2) One set of UTP/STP HDMI extended signal outputs.
Signal transmission up to 450 feet.
3) Standard single gang electrical box mountable.

b. Digital Receivers is Crestron DM-RX-1G or equal by Extron or Kramer

19. Digital Recorder

a. Characteristics
1) “Plug and present” design
2) Users train, lecture or present as usual with no special technical training
3) One-button recording
4) Automated recording options
Operator-free start/stop recording schedules
Integration with room automation touch panels
Remote web-based recording
5) Pause/resume live and on-demand recording

b. Live and on-demand
1) Webcast live via the web
2) Record on-demand presentations for users to watch at any time
3) Publish to a CD, DVD, USB or zipped folder to watch without an Internet connection

c. Interactive playback
1) Watch on any device - PC, Mac®, Linux®, iPad®, iPhone®, iPod®, Blackberry® or Android® device
2) User-controlled layouts
3) Image thumbnails, chapters and DVD-style presentation navigation
4) Powerful keyword search
5) Custom branding and links to related materials
6) Presenter-viewer interactivity with polls and ask a question
7) Closed captioning support
8) Smooth Streaming and encoding from 56Kbps to 2Mbps to support multiple bandwidths

d. Presentation editing
1) Video cropping (beginning/end) and video center-cut Replace video file
2) Add, delete, update and replace presentation slides Adjust slide timings
3) Add and customize chapters
4) Author new presentations by combining pre-recorded video and images

e. High resolution image capture
1) 1920 x 1200 maximum DVI digital resolution
2) 2048 x 1536 maximum analog RGB resolution
3) 480p, 720p, 1080p and 1080i HD resolutions

4) Full motion video support
5) Variable bit rate capture to support on-the-fly presentation device changes
6) Digital image capture using DVI-I interface

f. Optional analog image capture using VGA/
1) HDDB15 adapter
2) Video capture
3) HD/SDI
4) Composite BNC/RCA
5) Component BNC
6) S-Video (Y/C)
7) NTSC and PAL formats

g. Audio capture
1) 2 x balanced XLR (stereo)
2) 2 x unbalanced RCA (stereo)
3) Secondary audio
Line in - unbalanced 1/8” TRS (stereo)
Mic in - unbalanced 1/8” TS (mono)
Line out - unbalanced 1/8” TRS (stereo)
4) Design and dimensions
5) 2U rack-mountable to standard 19” rack
6) 160 GB hard drive
7) DVD drive (+/– RW)
8) 10/100/1000 Ethernet
9) DVI and DisplayPort out
10) Kensington lock for theft protection
11) Microsoft® Windows Embedded
12) Dimensions: 17.1”(w) x 3.4”(h) x 12.8” (d)
13) Weight: 13.5 lbs

h. Digital Recorder is Sonic Foundry Mediasite RL HD or equal by Media Pointe or Echo360. Provide capability to record 2 HD sources (2 HD cameras of the 3, each selectable, via touch panel). Provide Cat6A blue patch cord and connect to local data outlet. Install in booth rack.

20. HDMI to 3G SDI Extender Converter (Provide 1)
a. Capable of accepting an HDMI input signal and outputting 2 SDI outputs
b. HDCP Compliant
c. Send SDI output to digital media recorder as a second source.

Converter is model 1T-FC-766 by TVone or equal by Altona or Extron

21. AM/FM Tuner
a. The AM/FM Tuner shall provide output terminals for both RCA and XLR connections.
b. AM/FM Tuner shall have a 30 station random present memory.
c. AM/FM Tuner shall support radio data system functions included in carrier signals.
d. Display screen shall display AM/FM program service name, and current time.
e. Unit shall be rack mounted in booth rack
f. AM/FM Tuner Combination Unit is by Denon, Marantz, Tascam or equal.

22. Integrated Control System
    a. Control of all devices in the room must be integrated into a touch screen based remote control system. AMX corporations Axcent system, Crestron or equal by Extron. The District will provide necessary logo for the touch control pad.
    b. Provide integration and control for all audio source, and processing devices. This includes media selection, and transport controls were applicable.
    c. Provide integration to stage curtains (open/close, if motorized)
    d. Provide integration to production screen (up/down).
    e. Provide transport and selection controls for all audio source equipment. When possible, use RS-232 connections instead of IR.
    f. Provide transport and selection controls for all video source equipment (such as DVD, CD/iPod)
    g. Provide for full RS-232 based control over video projector.
    h. Provide for full RS-232/485 based control over video matrix switcher.
    i. Coordinate with electrical subcontractor to integrate pre-set lighting scenes for the house lighting system. Lighting system is RS-232/485 controllable. Coordinate with owner for scene selection.
    j. Provide Ethernet module for remote control of the system. District technology department will provide a fixed IP address.
    k. Provide two wired touch panels. One will be installed in Control Room, and a second at the roll-top desk by the sound control board (CoH).
    l. All touch panels shall be wired to the fire alarm control panel. Upon activation of fire alarm, the word FIRE will flash red across the screen and all audio source equipment shall be muted (including microphones). Electrical subcontractor shall provide the source, and communications subcontractor of this section shall install override and test. All audio programming shall be muted upon PA system activation. 275000 communications subcontractor shall provide source, and communications subcontractor of this section shall install override and test.
    m. Touch panels shall be integrated with the 3 HD cameras to allow PTZ operation of the cameras. Each camera as it is adjusted shall display its feed on the touch panel. Provide and install all equipment required to accomplish this function.
    n. Touch panel shall be integrated with digital media recorder to allow HD camera source selection, and to start and stop recording for 2 camera feeds simultaneously.
    o. Touch panel shall be programmed to contain an auto-mic button to allow automatic presentation of microphones connected to auto-mic labeled jacks (and designated wireless systems) over the sound system.
    p. Provide two (2) 12” touch panels, one at COH roll top desk and one at control booth, Model TPMC-V12 by Crestron or equal by AMX or Extron. Provide 2 power supplies for displays, PW-2420RU or equal by manufacturer of touch panel.
    q. Provide controllers for touch panels that are Ethernet capable. Provide all power supplies and related equipment for a fully functional system in accordance with design intent. Crestron Pro 2 with C2ENET-2 card or equal by manufacturer.
23. Equipment Racks
    a. Provide 19” Equipment Racks (left and right) in Roll-Top Desk at Central Audio Mixing location if not included in roll top desk.

b. Provide 44 Space metal equipment racks as necessary for equipment provided in auditorium control booth (min 1, Middle Atlantic ERK 4425 or equal) with locking door in Control Room. Provide rack mounted power strips as necessary to power rack equipment. Provide local input plate in rack in control booth with VGA input to AV switcher, 3.5mm audio input to AV switcher, RCA L&R input to DSP, HDMI input to AV switcher, HDMI output from AV switcher and RCA L&R audio output from DSP. Provide and install all AV inputs and outputs for these connections to audio video matrix switcher and DSP. Ensure specified rack can house all equipment; otherwise provide and install appropriate sized rack.

c. Provide rack of appropriate size in stage area (labeled mic rack) by Middle Atlantic Products or equal by Sanus or Peerless.

24. Roll Top Desk

a. Provide lockable roll-top desk with 19” equipment racks on the lower left and lower right side.

b. Ensure desk is sized to fit the mixer, all source audio equipment, touch panel control and telephone, assistive listening units, and other equipment. Min size of desk tabletop is 68 inches wide by 31 inches deep by 12 inches from table top to roll top.

c. Color shall be golden oak. By HSA Rolltop or equal

25. Shotgun Microphones

a. Shotgun Microphones AT8015 shall be wired to the stage mic rack.

b. Wide dynamic range

c. Frequency response: 50Hz to 17 KHz

d. Impedance: 150 ohms balanced

e. SNR: 66dB at 94 dB SPL

f. Operating voltage: Phantom power 11 to 52 VDC, pos voltage on pins 2 relative to pin 3 of output connector.

g. Finish: Black, include black windscreen

h. Include power supply if required.

i. Shotgun microphones (M on drawings on light bar in auditorium) shall be model AT8015 by Audio-Technica or equal by Crown or Samson. Provide appropriate model for auditorium presentations. Coordinate placement with owner. Cross align mics aimed at stage to pick up performers voices (right one aiming left, left one aiming right).

j. Coordinate cabling and connections with theater section for cabling provided on light bar by theater section to support microphones.

26. Microphones, Stands, Cords

a. Provide :

1) 8 microphones:

a) Provide 2 Shure Beta 57 microphones or equal by Peavey or Crown

b) Provide 2 Shure Beta 58 microphones or equal by Peavey or Crown

c) Provide 2 Shure SM81 microphones or equal by Peavey or Crown

d) Provide 2 Crown PCC160 microphones or equal by Peavey or Crown

2) 6 microphone stands

3) 8 microphone cords, XLR terminated, 25’

27. Provide and install required switches, PoE/PoE+ if required, for system control in all racks. Note any amplifiers requiring network connectivity, and provide switch with appropriate amount of ports to support all equipment.

2.3 Small Group Seminar

A. General:

1. Small Group Seminar room shall be equipped with a local sound reinforcement system with left and right program speakers, one subwoofer, four speakers for lower side seating, four speakers for upper balcony seating and a speaker for rear seating. Speakers shall be mounted in permanent locations as shown on the drawings. Provide adequate speaker coverage.
2. Digital signal processors (DSPs) and audio program equipment shall be installed within a 19" full rack to be installed in the specified location.
3. TCP/IP Based Video teleconferencing system with presenter and audience cameras will be provided.
4. LCD Video projector will be mounted to the ceiling where shown (V7) on the drawings. Provide lens required for full screen viewing. Projector must be able to display up to two simultaneous video sources.
5. Video output from a laptop at the cabinet on first floor shall be sent to the video switcher for presentation of material on the screen above it via the ceiling mounted projector.
6. Provide control system with 8.4" min wireless touch panel and controller for all installed equipment. Provide touch panel dock in wall above cabinet on bottom floor, cabled back to the rack on the balcony.
7. Install the presentation camera listed in 2.1 above. Presentation camera provided by owner, installed by 274000. Connect HD video output of presentation camera directly to video switcher (presentation camera is DVI output) for use without a laptop, and provide a USB cable to connect to a laptop at the builtin for future use. Provide input at video switcher for this HD video connection.
9. Provide one HDMI output on video switcher and provide HDMI cabling from AV switcher and audio cabling from DSP to connect one IPTV HD encoder (provided by 27 70 00) to broadcast teleconferencing cameras over the IPTV network.
10. This specification is designed to define the desired operating criteria and suggested equipment. Communications subcontractors shall design and provide a fully operational system including labor, materials, and equipment.

B. Capabilities:

1. The system shall provide the following capabilities:
   a. Ability to power-up, select, and control media source materials, control pre-set room lighting scenes (if available), and raise/lower projection screen from a wireless video touch panel located at the front of the room.
   b. Ability to display video source (IPTV, DVD, Video Teleconferencing and Computer) material using a multimedia projector system.
   c. Ability to distribute audio programming from CD/iPod combination, microphones, video source material, local computer, video teleconferencing system, and building PA system.
   d. Ability to record in HD all teleconferences.
   e. Provide HDMI input, VGA input and 3.5mm audio input on front of rack to allow presentation of video and audio over the projectors and sound system.
   f. Provide two microphone jacks on sound system rack for microphone input to the system.
   g. Provide two XLR inputs at the rack for owner provided sound effect boards. Program each input individually. One input shall be sent and mixed with program audio to the upper balcony speakers, and the other XLR input shall be sent and mixed with program audio to the lower side seating speakers.
   h. Program appropriate delay for proper summing with left and right program audio for balcony and lower side speakers (not the center speaker for back seating) such that the balcony and lower side seating can be selected to be

used for program audio along with the front Left and Right speakers if desired. This configuration shall be selectable on the touch panel. The center speaker for the back seating shall be used for drama and microphone outputs instead of the front program speakers. The choice to use the front left and right program speakers vs the center speaker for the back seating shall be selectable on the touch panel.

C. Products:

1. 8 channel minimum DSP Mixer with AEC at mic / line inputs
   a. The mixer shall have a minimum of eight mixer input ports.
   b. Provide a rack mount bracket.
   c. Unit must be equipped to mute current audio program if building PA system is activated. PA system communications subcontractor to provide program source.
   d. Telephone interface required.
   e. Serial port for third party RS232 Control
   f. DSP is Nexia TC and Nexia VC in quantities needed for design intent, or equal by Clearone or QSC.
2. CD iPod Dock Combination Unit
   a. Plays audio CDs, MP3 CDs and WAV file CDs
   b. Provide output terminals for both RCA and XLR connections
   c. Dock connector for Apple iPod charging and playback
   d. iPod video playback from S-video or composite output
   e. CD TEXT and ID3 tag support
   f. Continue, Random and Program play modes
   g. Repeat All and Repeat Single play modes
   h. Index Search
   i. Shock/skip prevention memory buffer
   j. ±12% pitch control (analog outputs only)
   k. RCA unbalanced line outputs (CD and iPod)
   l. Coaxial and Optical S/PDIF digital out (CD only)
   m. 1/4” stereo headphone output
   n. 2u rack mountable
   o. Wireless 55-key remote control
   p. 19”W x 3.72” H x 11.73”D
   q. Install in a 19” rack inside the cabinet on floor one, cabled to the rack on floor two.

   CD/ iPod dock is a Tascam CD-200i or equal by Denon or Marantz.
3. Blue Ray Player
   a. Supports Super Audio CD and DVD-Audio formats
   b. Support Blu-ray 3DTM playback(1)
   c. Network functions, capable of playing YouTube and Netflix video distribution services without a PC, music, photo, and video files stored on a network-connected device such as a PC or NAS.
   d. Support Deep Color, “x.v.Color”, High-Bit-Rate Audio output and HDMI control function
   e. High quality 32-bit/192kHz audio digital to analog converters
   f. High quality 12-bit video digital to analog converter
   g. USB port on the front
   h. Direct Mechanical Ground Construction, to suppress vibration and ensure high-quality HD sound and video
   i. Independent Block Construction, for faithful playback of audio and video

signals

j. Advanced High-bit I/P Scaler, for a more detailed picture and depth in colors
k. 1080p/24 video output, to bring out the full quality of film
l. Deep color support
m. 3-D digital noise reduction
n. HDMI source direct mode to output native resolution of the disc
o. Picture adjustments
p. Gold plated terminals
q. User friendly GUI
r. Glo-key remote controller
s. AMX, Crestron third party control support via RS-232C Custom Integration
t. Remote In/Out connection
u. Remote lock mode
v. Supports Super Audio CD and DVD-Audio formats
w. Support Blu-ray 3DTM playback
x. Dolby TrueHD and DTS-HD Master Audio HDMI output
y. Advanced High-bit I/P Scaler
z. 1080p/24 video output
aa. Supports Super Audio CD and DVD-Audio formats.
bb. Supports Blu-ray discs, DVDs, CDs, Super Audio CDs, and DVD-Audio.
cc. Plays compressed content such as music and video files. Supports DivX® video files stored on USB memory, DVD-R/RW or other recordable media, MP3 and WMA music files, JPEG files taken with a digital camera, as well as WMV video files and MPEG-AAC music files.
dd. Versatile Disc Formats Playability
    1) BD-Video
    2) BD-R (BDMV format)
    3) BD-RE (BDMV format)
    4) DVD-Video
    5) DVD-Audio
    6) DVD+R, DVD+RW (Video mode, AVCHD format)
    7) DVD-R, DVD-RW (Video mode, AVCHD format)
    8) Super Audio CD
    9) Audio CD
    10) CD-R, CD-RW
    11) Kodak Picture CD
ee. Other Features
    1) HDMI resolution select on front panel
    2) Detachable AC cord
ff. Ports
    1) Video
        1. HDMI output x 1
        2. Component output x 1
        3. Composite output x 1

2) Audio
   1. Coaxial digital output x 1
   2. Analog output (2ch, L/R) x 1
   3. Analog output (7.1ch audio out) x 1
3) Control
   1. Ethernet x 1
   2. USB port x 1
   3. RS-232Cx 1
   4. Remote control (IN / OUT) x 1 / x 1

gg. Main Specifications
1) Video
   1. Signal system
      a. PAL/NTSC
2) Audio
   1. S/N
      a. 125 dB
   2. Total harmonic distortion
      a. 0.0008% (2ch, L/R)
   3. Dynamic range
      a. 110 dB
3) General
   1. Power supply
      a. 110 - 240 V, 50/60 Hz
4) Dimensions
      a. W x H x D 434 x 107 x 319 mm (incl. protrusions)
5) Weight
      a. 5.2 kg

f. Install in a 19” rack inside the cabinet on floor one, cabled to the rack on floor two.

hh. Blue Ray player is Denon BDP-2012UD or equal by Marantz or Tascam

4. Speakers
a. Provide program left and right speakers, on front soffit of room.
b. Mount speakers to the left and right side where shown on the drawings (SPr).
c. Speaker parameters:
   1) Frequency range: 80Hz – 16kHz
   2) Sensitivity: 121dB-SPL @ 1W, 1m (pink noise)
   3) Dispersion: Horizontal:90 degrees; Vertical: 60 degrees
   4) Long term power handling: 250W continuous
   5) Impedance: 8 ohm nominal (70v/100v optional)
   6) Color: Black
   7) Provide all brackets, mounts, rigging, and connectors required to mount speakers in location shown on the drawings.
   8) Speaker model is Bose RoomMatch RMU108 or equal by JBL or EAW.
d. Provide one subwoofer, flown from the ceiling/pipe grid (SPr2 symbol). Bose model LT MB24 III or equal by EAW or JBL. Color must be Black.
e. Provide four under balcony speakers, Bose RMU105 or equal by JBL or EAW. Color must be black. Provide and install hardware to mount these to ACT tiles

or structure above ACT tiles.

f. Provide four upper balcony speakers, Bose RMU105 speakers, rigged to the pipe grid firing down, or equal by EAW or JBL. Color must be black. Provide and install hardware to mount these to ACT tiles or structure above ACT tiles.
g. Provide one center speaker, mounted to pipe grid above projector screen, covering the rear seating area. Bose RMU208 or equal by JBL or EAW.

5. Amplifiers (Qty 2 min)
   a. Provide and install two Bose PM8500N amplifiers, one configured to power the 8 balcony/under balcony RMU105s and the center RMU208 speaker, the other configured to power the subwoofer and front right and left speakers.
      1. Upper balcony speakers (4) 1 channel per speaker.
      2. Under balcony speakers, (4), 2 speakers per channel.
      3. Center speaker 2 channels, bridged.
      4. Front right and left program speakers: 2 channels, bridged to each speaker.
      5. Subwoofer: 2 bridged channels per speaker, there are 2 speakers in the subwoofer.
   b. Mount all amplifiers in equipment rack at the balcony
   c. Provide and install all switching required for design, in port densities required.
   d. Amplifiers are by Bose or equal by Crown International, CT Series, Crest or Hafler.
   e. Provide and install three ESPlink cards and one ControlSpace ESP-1240(RTC)
   f. See T2.8 for speakers and bridging requirements.
6. Wireless microphone system (provide 5 complete systems)
   a. Power On Indicator
   b. “RF” Diversity Signal Indicators
   c. Transmitted (TX) Audio Indicators
   d. Receiving Antenna Indicator
   e. Group/Channel Displays
   f. Transmitter Battery Life Indicator
   g. MODE Button for Menu Display
   h. SET Button for Saving Settings
   i. Mic/Line level Switch
   j. XLR and ¼” outputs with level control
   k. Provide rack mounting kit, and mount in equipment cabinet, not in sound system rack.
   l. Provide 1 handheld microphone, one headworn microphone, and one lapel microphone/transmitter combination on the same frequencies for each system. Devices will not be used concurrently.
   m. Mount antennas where required for 100% room coverage. Provide all amplifiers, antennas, rigging and cabling required. Coordinate antenna placements with Architect.
   n. Install in a 19” rack inside the cabinet on floor one, cabled to the rack on floor two.
   o. Model is the Shure ULXS4 Standard, with Rack Mounting Kit or equal by Electro-Voice or Sennheiser.
7. Video Projector with Mount.
   a. Provide a minimum 6500 lumens high-quality multimedia projector designed for a small to medium size presentation room with long throw lens sized to fit the full screen from the back wall. Color must be black.
   b. Projector shall accept data, graphics and video inputs for use in front, rear and ceiling-mounted projection and screen sized from 31” to 300” diagonal.
   c. Projector shall features auto-setup functionality allowing fast plug & play set-up to RGB computer signals (VGA to WXGA) and use a digital visual interface

(DVI) to offer picture-perfect digital connectivity to computer video cards, composite video, s-video and component video inputs.

d. Projector shall have functions such as digital scaling; digital keystone and power zoom & focus to perfectly place a bright and crisp projected image.
e. Specifications
   1) Min. native WUXGA resolution (1920 x 1200)
   2) Min contrast Ratio 2500-10,000 (full on/off); 650:1 ANSI (typ)
   3) Digital and analog connectivity for data and video sources
   4) DTV and HDTV compatibility
   5) Robust magnesium alloy case
   6) Motorized zoom and focus
   7) VGA to QXGA
   8) Digital keystone correction and scaling
   9) Intuitive on-screen displays (OSD)
   10) HDMI, DVI, VGA and Component inputs
   11) Ethernet port (provide LAN cable and connect to data port)
f. Provide and install at V7 location specified on drawings.
g. Projector shall provide sufficient horizontal and vertical lens shift to compensate for being off top of screen and askew of centerline without key stoning
h. Provide appropriate lens for distance of projector to screen to fully fit screen at 16:10 ratio.
i. Mount projector from ceiling (include pole mount) as close to the ceiling as possible using lens shift but not keystone correction to achieve full image on screen. Provide anti-vibration mount if image vibration is observed. General contractor shall provide blocking required for proper safe installation. Coordinate blocking required with general contractor.
j. Video projector manufacturer is WU7K-M by Christie or equal by Infocus or Mitsubishi.

8. Microprocessor controlled Fully Digital Matrix Video Switcher
   a. SUMMARY
      1) The HD Digital Transport and Distribution System shall include providing and integrating the following principal systems:
         1. Audio/Video switching.
         2. Audio/Video distribution at native resolution without compression.
         3. Video interface equipment.
         4. Audio interface equipment.
         5. HDMI signal transport.
         6. HDCP support.
         7. Deep Color support.
         8. EDID management.
         9. HDCP KSV handling/management.
         10. Digital diagnostic tools.
   b. The AV switching system shall support at least 6.75Gbps of data transfer on each input and output to support 1080p 36-bit (Deep) Color video resolutions without compression.
   c. The AV switching system shall support 8 channel audio.
   d. The AV switching system shall support audio breakaway from video.
   e. The AV switching system shall support the HDMI specification of less than 1 in 1x10-9 bit errors at 1080p 36-bit (Deep) Color.

f. The AV switching system shall downmix multi-channel audio into 2-channel audio so that the same audio content may be routed to both multi-channel and 2-channel sinks.

g. The AV switching system shall be able to dither between standard and deep color video signals on each input and output.

h. The AV switching system shall support the following AV signal inputs:
   1) HDMI 1.3a (High Definition MultiMedia Interface)
   2) DVI 1.1 (Digital Visual Interface)
   3) DisplayPort Multimode 1.1
   4) Analog RGB
   5) YPbPr
   6) S-Video
   7) CVBS
   8) SPDIF
   9) Analog Stereo Audio

i. The AV switching system shall transcode the AV signals to a single signal type for distribution.

j. The AV distribution system shall route AV signals from any input to any output with less than 1ms of latency.

k. The AV distribution system shall not require extra cabling to transmit the following control signals for AV sources and sinks:
   1) RS-232
   2) Infrared
   3) Ethernet
   4) USB Human Interface Device-class devices
   5) Contact closure

l. EDID MANAGEMENT
   1) The AV switching system shall allow configuration of the EDID presented to sources on each AV input.
   2) Each input on the AV switching system shall be configured independently.
   3) The AV switching system shall by default present an EDID to each input that includes only the video timings and audio formats common all sinks connected to the outputs.
   4) The AV switching system shall allow the user to enter each input's EDID video timings individually.
   5) The AV switching system shall allow the user to enable and disable support for the following items in each input's EDID.
      1. Deep color
      2. 3D support

m. HDCP MANAGEMENT
   1) The AV switching system shall support HDCP 1.1 or greater.
   2) The AV switching system shall detect the number of KSVs supported by each source.
   3) The AV switching system shall not send a source more KSVs than it supports.
   4) The AV switching system shall cache the KSVs from each connected sink.

5) The AV switching system shall authenticate all cached KSVs with each source up to the source's KSV limit, so that authentication does not need to be re-started each time content is routed to a new output.

n. SIGNAL DETECTION

1) The AV switching system shall report the following incoming signal information to an AV control system:

a) Signal detect

b) Horizontal and vertical resolution

c) Signal refresh rate

d) Presence of HDCP

o. The AV switching system shall report the following information to an AV control system:

1) HDCP authentication status for each source and sink

2) EDID Preferred video timing for each sink

3) Maximum number of KSVs supported by each source

p. TROUBLESHOOTING

1) The AV switching system shall report the following information for troubleshooting:

2) Maximum number of KSVs supported by each source

3) The number of KSVs sent to each source

4) EDID indicated Video timings and audio formats supported for each sink

5) EDID presented to each source

6) The AV switching system shall support off-site remote troubleshooting via Ethernet

q. SYSTEM DESIGN

1) The communications subcontractor shall provide AV source equipment with support for enough KSVs so that it can be routed to all sinks simultaneously.

2) If a particular AV source cannot be found to support enough KSVs to route to all sinks simultaneously, the communications subcontractor shall:

a) Notify the Engineer

b) Configure the AV switching equipment so that it shall not send an AV source more KSVs than it supports.

3) The communications subcontractor shall configure the EDID presented to each AV source to indicate only the video timings supported by ALL sinks used for viewing and distributing video.

4) The communications subcontractor shall configure the EDID presented to each AV source to indicate support for only the audio formats actually supported by ALL the sinks used for distributing audio.

5) The communications subcontractor shall verify the data rate supported by each shielded twisted pair cable used for AV distribution.

6) The communications subcontractor shall provide display equipment that does not overscan the video signal when full-pixel sources are routed.

r. DEMONSTRATION AND ACCEPTANCE TESTING

1) The communications subcontractor shall provide a copy of the following information in electronic format in order to verify the AV switching equipment has been installed and configured correctly:

2) The number of HDCP KSVs УKeysΦ supported by each source
3) The video timing, HDCP use and audio format of each source when operating (not needed for walk-in equipment)
4) The video timings and supported audio formats for each connected sink
5) The video timings and supported audio formats presented in the EDID to each source – the preferred video timing shall be indicated
6) The length of cable used on all shielded twisted pair cable used for AV distribution
7) The data rate supported by each shielded twisted pair cable used for AV distribution
8) The HDMI Matrix shall consist of a card-cage type unit, capable of accepting different input and output cards.
9) Any input shall be routable to any output. Matrix shall provide almost instantaneous HDMI switching for sources with HDCP. Breakaway audio, video, and USB switching shall also be available.

s. 16x16 Matrix – 16 inputs, 16 outputs
   1) The matrix shall meet the following minimum requirements:
      1. Ethernet support.
         a. Gigabit uplink.
         b. Integrated 10/100 managed Ethernet switch.
      2. Sixteen (16) field configurable input card slots.
      3. Four (4) factory configurable output card slots.
         a. Output card accommodates 4 signal outputs.
      4. Easy software setup tool.
      5. Front panel LCD diagnostic screen.
         a. HDCP key register detection.
         b. HDMI Cable test tool.
         c. Automatic resolution management via EDID.
      6. HDCP digital rights key management.
      7. Fast HDMI switching with keep-alive HDCP link.
      8. CEC signal management.
         a. Intercept CEC data being sent from HDMI devices.
         b. Send control information.
   2) The matrix shall be a Crestron DM-MD16X16 or equal by Extron or Kramer. (Provide 1)

t. HDMI Input Card w/DSP (provide in quantity for design intent)
   1) The HDMI input card shall accept an HDMI signal. It shall provide a 2-channel mix of multi-channel audio sources. The original audio track(s) shall also be preserved and passed through to the matrix. This signal shall be available as an output on the matrix.
   2) The HDMI input card shall meet the following minimum requirements:
      1. One (1) HDMI input.
         a. 19-pin type A female HDMI connector.
         b. Supports HDCP 1.1.
         c. Supports HDMI 1.3 with Deep Color.

2. One (1) HDMI output.
    a. Buffered output from video input.
    b. Audio consists of either 2-channel mixed audio or original multi-channel audio track.
    c. 19-pin type A female HDMI connector.
    d. Supports HDCP 1.1.
    e. Supports HDMI 1.3 with Deep Color.
3. One (1) USB 1.1 port for USB HID data.
    a. Mouse, keyboard, game controller, or other USB HID device support.
    b. USB Type A female connector.
4. Audio processor.
    a. HD audio decoder DSP.
    b. Dual 32-bit cores.
    c. Support for various audio/surround formats:
        i. Bypass.
        ii. Stereo.
        iii. PCM 96/24.
        iv. MLP Lossless.
        v. Dolby Pro Logic IIx.
        vi. Dolby Digital 5.1.
        vii. Dolby Digital EX.
        viii. Dolby TrueHD.
        ix. DTS Neo:6.
        x. DTS Virtual.
        xi. DTS Digital 5.1 Discrete.
        xii. DTS ES 6.1 Discrete.
        xiii. DTS ES 6.1 Matrix.
        xiv. DTS 96/24.
        xv. DTS-HD Master Audio.
5. Digital to analog converter.
    a. 24-bit, 48 KHz
6. Provide 2-channel mix of either surround audio or 2-channel pass-thru audio on one (1) stereo analog audio output.
    a. Two (2) RCA female connectors.
    b. Unbalanced line-level output.
    c. Provides pass-through signal converted from HDMI input.
    d. Maximum Output Level: 2 Vrms.
    e. Output Impedance: 100 ohms nominal.
7. Analog shall meet or exceed:
    a. Frequency response: 20Hz to 20kHZ ±0.5dB.
    b. S/N Ratio: >95dB, 20Hz to 20kHz A-weighted;
    c. THD+N: <0.005% @ 1kHz;
    d. Stereo Separation: >90dB

3) The input card shall be a Crestron DMC-HD-DSP or equal by Extron or Kramer.

u. DVI Input Card (provide in quantity for design intent)

1) The Video Input Card shall accept a DVI video signal, injected audio and convert to HDMI signal. This signal shall be available as an output on the matrix.

2) The HDMI input card shall meet the following minimum requirements:

1. One (1) DVI input.
2. One (1) DVI-I female connector.
3. Auto-sensing multi-format analog video input.
4. Support for the following video types:
   a. DVI
   b. YPbPr (component).
   c. Y/C (S-Video).
   d. RGB
5. Support for the following video formats:
   a. NTSC
   b. PAL
6. Support for the following video resolutions:
   a. 480i
   b. 480p
   c. 576i
   d. 576p
   e. 720p
   f. 1080i
   g. 1080p
7. Video analog to digital converter.
   a. 10-bit, 170MHz.

3) One (1) HDMI output.

1. Buffered output from input.
2. 19-pin type A female HDMI connector.
3. Pass through of video input signal (matched format/resolution).
4. Pass through of audio input signal.

4) One (1) analog audio input.

1. One (1) 5 pin 3.5mm terminal block- detachable.
2. Pass through to HDMI output.

5) The input card shall be a Crestron DMC-DVI or equal by Extron or Kramer.

v. 3G-SDI Input Card (provide in quantity for design intent)

1) The Video Input Card shall accept SD-SDI, HD-SDI and 3G-SDI video signal, injected audio and convert to HDMI signal. This signal shall be available as an output on the matrix.

2) The SDI input card shall meet the following minimum requirements:

1. One (1) SDI input.
2. One (1) BNC female connector.

3. Auto-sensing multi-format analog video input.
4. Support for the following video types:
   a. SD-SDI (SMPTE 259M)
   b. HD-SDI (SMPTE 292M)
   c. 3G-SDI (SMPTE 424M)
5. Support for the following video resolutions:
   a. SMPTE 425M (3G-SDI) 4:2:2 Colorspace: 1920x1080@50Hz (1080p50), 1920x1080@60Hz (1080p60);
   b. SMPTE 425M (3G-SDI) 4:4:4 Colorspace: 1280x720@50Hz (720p50), 1280x720@60Hz (720p60), 1920x1080@24Hz (1080p24), 1920x1080@25Hz (1080p25), 1920x1080@30Hz (1080p30), 1920x1080@50Hz (1080i50 or 1080sF25), 1920x1080@60Hz (1080i60 or 1080sF30);
   c. SMPTE 260M (HD-SDI): 1920x1035@60Hz (1035i60); SMPTE 295M (HD-SDI): 1920x1080@50Hz (1080i50); SMPTE 274M (HD-SDI): 1920x1080@24Hz (1080p24), 1920x1080@24Hz (1080sF24), 1920x1080@25Hz (1080p25), 1920x1080@30Hz (1080p30), 1920x1080@50Hz (1080i50 or 1080sF25), 1920x1080@60Hz (1080i60 or 1080sF30); SMPTE 296M (HD-SDI): 1280x720@50Hz (720p50), 1280x720@60Hz (720p60);
   d. SMPTE 259M-C (SD-SDI): 720x480@59.94 (NTSC), 720x576@50i (PAL)
6. One (1) SDI (loop-thru) output
   a. One (1) BNC female connector
7. Output Resolutions
   a. Matched to Inputs
8. Video analog to digital converter.
   a. 10-bit, 170MHz.
9. One (1) HDMI output.
   a. Buffered output from input.
   b. 19-pin type A female HDMI connector.
   c. Pass through of video input signal (matched format/resolution).
   d. Pass through of audio input signal.
10. One (1) analog audio input.
   a. One (1) 5 pin 3.5mm terminal block- detachable.
   b. Pass through to HDMI output.

3) The input card shall be a Crestron DMC-SDI or equal by Extron or Kramer.

w. UTP/HDMI Output Card (Provide in quantity for design intent).

1) The UTP/HDMI output card shall be compatible with the HDMI Matrix. Output cards shall transmit any input signal. Output cards shall have various arrangements of connector types. Output cards shall have up to eight (8) outputs per card. Output card output types shall be as follows:
   1. UTP/STP Type 2 (DM 8G+) Output (x2)
   2. The UTP/STP Output shall provide transmission of any HDMI signal inputted to the matrix.
   3. The Output Card shall interface with (2) unshielded twisted-pair or

shielded twisted pair cable.

4. 4 HDMI with Stereo analog outs

2) The Output Card shall be a Crestron DMCO-5330 or equal by Extron or Kramer.

9. Digital Receiver

a. The receiver shall accept the HD signal via UTP/STP wire and convert it to one (1) HDMI output. When used with a supported control system, the receiver shall provide local control to device(s). In addition, when used with the Matrix switcher, the receiver shall provide Ethernet connectivity to any compatible devices.

b. The receiver shall meet the following minimum requirements:

1) Scaler

1. HD video scaler, motion-adaptive deinterlacer, interlacer, intelligent frame rate conversion, Deep Color support, 3D to 2D conversion[2], content-adaptive noise reduction, widescreen format selection (zoom, stretch, maintain aspect-ratio, or 1:1), video wall processing (2x2, 3x2, 3x3, 4x3, or 4x4)[5]

2. Input Resolutions Progressive

a. 640x480@60Hz, 720x480@60Hz (480p), 720x576@50Hz (576p), 800x600@60Hz, 848x480@60Hz, 852x480@60Hz, 854x480@60Hz, 1024x768@60Hz, 1024x852@60Hz, 1024x1024@60Hz, 1280x720@50Hz (720p50), 1280x720@60Hz (720p60), 1280x768@60Hz, 1280x800@60Hz, 1280x960@60Hz, 1280x1024@60Hz, 1360x768@60Hz, 1365x1024@60Hz, 1366x768@60Hz, 1400x1050@60Hz, 1440x900@60Hz, 1600x900@60Hz, 1600x1200@60Hz, 1680x1050@60Hz, 1920x1080@24Hz (1080p24), 1920x1080@25Hz (1080p25), 1920x1080@50Hz (1080p50), 1920x1080@60Hz (1080p60), 1920x1200@60Hz, plus any other resolution allowed by HDMI up to 165MHz pixel clock

3. Input Resolutions Interlaced

a. 720x480@30Hz (480i), 720x576@25Hz (576i), 1920x1080@25Hz (1080i25), 1920x1080@30Hz (1080i30), plus any other resolution allowed by HDMI up to 165MHz pixel clock

4. Scaler Output Resolutions, Progressive

a. 640x480@60Hz, 720x480@60Hz (480p), 720x576@50Hz (576p), 800x600@60Hz, 848x480@60Hz, 1024x768@60Hz[6], 1280x720@50Hz (720p50), 1280x720@60Hz (720p60), 1280x768@60Hz, 1280x800@60Hz[6], 1280x960@60Hz, 1280x1024@60Hz, 1360x768@60Hz, 1366x768@60Hz[6], 1400x1050@60Hz[6], 1440x900@60Hz[6], 1600x900@60Hz[7], 1600x1200@60Hz, 1680x1050@60Hz[6], 1920x1080@50Hz (1080p50), 1920x1080@60Hz (1080p60), 1920x1200@60Hz[7]

5. Scaler Output Resolutions, Interlaced

a. 720x480@30Hz (480i), 720x576@25Hz (576i), 1920x1080@25Hz (1080i25), 1920x1080@30Hz (1080i30)

6. Pass-Thru Output Resolutions

a. Matched to Input

2) HDMI digital video/audio output.
   1. One (1) 19-pin Type A HDMI female connector.
3) One (1) USB 1.1 port for USB HID data.
   1. Mouse, keyboard, game controller, or other USB HID device support.
   2. USB Type A female connector.
4) One (1) bidirectional RS-232 port.
   1. One (1) 5-pin 3.5mm detachable terminal block.
   2. GND, TX, RX, CTS, RTS support.
   3. Up to 115.2k baud, hardware and software handshaking support.
5) Two (2) IR/Serial ports.
   1. One (1) 4-pin 3.5mm detachable terminal block.
   2. IR output up to 1.1 MHz.
   3. 1-way serial TTL/RS-232 (0-5 Volts) up to 19200 baud.
6) One (1) 10/100 LAN port.
7) One (1) STP input.
   1. One (1) RJ-45 female connectors.
8) One (1) power input.
   1. (1) 2.1mm barrel DC power jack.
9) Shall support transmission distances of up to 450ft.
10) Mountable to a 2-gang, 4" square, or Euro electrical box.

c. Digital Receivers shall be Crestron DM-RMC-SCALER-C or equal by Extron or Kramer. (Provide 1 for room projector).

10. Integrated Room Control System
   a. Provide a wireless touch panel based integrated control system with wireless gateway equipment (provide equipment for wireless touch panel functionality from any location in room). Provide dock charging panel for touch panel mounted above cabinet on first floor of room.
   b. Provide down converter, C2-2100 or equal by Atlona or Extron. Connect to an output of video switcher.
   c. Provide network streamer, CEN-NVS200 or equal by Extron or Atlona. Connect to down converter.
   d. Provide PoE switch, connect to network streamer.
   e. Provide wireless access point to broadcast network stream in room. Connect to PoE switch. Position WAP for 100% room coverage of the wireless touch panel. Coordinate antenna/wap location with architect.
   f. 8.4” Wireless WiFi Touch Panel
      1) Features
         a) 8.4” active matrix touch screen display
         b) 800 x 600 SVGA display resolution
         c) 16 bit Isys i/O graphics
         d) Synapse image rendering algorithm
         e) 802.11a/b/g Wi-Fi 2-way wireless communications
         f) Windows XP Embedded operating system
         g) Onboard PC applications for Web browsing, streaming media, conferencing, VoIP, and remote desktop
         h) Wireless video from network cameras and servers

i) Built-in microphone and stereo speakers
j) 5-way thumbpad and 4 "Softkey" buttons
k) Includes stylus with onboard storage slot
l) Built-in biometric fingerprint scanner
m) Built-in Bluetooth technology
n) Internal Li-Ion battery pack included

2) SPECIFICATIONS
   a) Touch Screen Display
   b) Display Type
      1. TFT Active matrix color LCD
   c) Size
      1. 8.4 inch (305 mm) diagonal
   d) Aspect Ratio
      1. 4:3 SVGA
   e) Resolution
      1. 800 x 600 pixels
   f) Brightness
      1. 200 nits (cd/m²)
   g) Contrast
      1. 500:1
   h) Color Depth
      1. 18-bit, 262k colors
   i) Illumination
      1. Edgelit fluorescent
   j) Viewing Angle
      1. ±65° horizontal, +65° / -45° vertical
   k) Touch Screen
      1. Resistive membrane
   l) Buttons & Indicators
      1. 4 softkey
      2. Programmable 5 way thumbpad (4-way plus center ENTER button
      3. 2 programmable up/down pushbuttons
   m) Communications
      1. RF Transceiver
         a. IEEE 802.a/b/g Wi-Fi, 5 or 2.4GHz 2-way RF
      2. Bluetooth
         a. Bluetooth V1.2 Class 1 built in
   n) Video
      1. MPEG4 & MJPEG
   o) Audio
      1. Dual onboard microphones
      2. Builtin speakers

3. Stereo headphone out

c. 8.4" Wireless Touch Panel is Crestron TPMC-8XGA or equal by AMX or Extron

d. System shall control the following devices:

1) DVD, Power and Transport
3) CD/iPod Unit, Power and Transport Controls
4) Matrix Switcher
5) Projector power and selection controls, both projectors
6) Projection Screen (Up/Down)
7) Room lighting scenes
8) Both teleconferencing cameras, PTZ functions (camera feed shall be viewable on wireless touch panel)
10) Teleconferencing system start/stop recording function
11) Speaker selections

e. Communications subcontractor shall design a graphical user interface to control and switch all devices above. Owner must approve screen design prior to system programming.

f. Touch panel shall be integrated with fire alarm control panel. Upon fire alarm activation, touch panel shall flash the word FIRE in red on the screen and all audio sources shall be muted. Electrical subcontractor shall provide source, communications subcontractor of this section shall install override and test. All audio programming shall be muted upon PA announcement. 275000 communications subcontractor shall provide source, communications subcontractor of this section shall install override and test

g. Provide controller that is Ethernet capable for touch panel. Provide all power supplies and related equipment for a fully functional system in accordance with design intent. Crestron Pro 2 with C2ENET-2 card or equal by AMX or Extron.

h. Provide wireless touch panel dock and install in wall above cabinet at front of room.

11. Video Teleconferencing System

a. Provide a TCP/IP based video teleconferencing system with one instructor camera, and one audience camera mounted at V1 locations. Communications subcontractor shall provide faceplate details and required cabling when system is submitted.

1) Input:

LifeSize Room 220 provides support for two active camera sources at 720p30 with a Wide-angle zoom lens with 70 degree field of view, 4x Optical zoom, Auto focus / Automatic gain control, 10 camera presets (near and far end)
2 x High Definition Camera (720p30)
2 x HD Video In (1080p30/720p30)
1 x DVI-I In (HDMI/VGA enabled)
1 x Component In or 1 x Composite In
1 x S-Video In (VGA enabled)
Output:

Utilizing a Standard 3.0 M HDMI cable (or extended HDMi using Extron DVI-201 HDMi-Ethernet extenders via Cat-5 transmitter/receiver or equal by Kramer or Crestron): 1 x HD Video Out (1080p30/720p60)
1 x DVI-I Out (1080p30/720p60)

2) Communications:

H.323, SIP
128Kbps - 8.0Mbps (point-point)
128Kbps - 2.0Mbps (multipoint, per call)
1xRJ-45 Network LAN (10/100 Mbps)

1xRJ-45 for LifeSize Phone (PoE supported)
1xRJ-45 for LifeSize Networker (PoE supported)
1xRJ-11 for analog telephone line
1x3.5mm Mic In for LifeSize MicPod

3) Audio Standards
G.711, G.722, G.722.1 (Polycom© Siren14™), G.728, G.729,
MPEG-4 -AAC-LC
Audio Inputs (8 Inputs)
1 x RJ-45 (LifeSize Phone)
2 x Stereo Line In (3.5mm)
AC Voltage 100-240V, 50-60 Hz, 2.5A via external power

4) Mount cameras at locations specified on the drawings, V1 locations. See room elevations in architectural section of drawings and technology drawings. Provide 2 HD cameras (one at each V1 location). Camera specifications:
   a) 720 resolution min
   b) 20x optical room and 12x digital zoom
   c) Pan angle/speed: +/- 170 degrees 100 degrees per second
   d) Tilt angle/speed: +90 degrees/-20 degrees 90 degrees per second
   e) Horizontal viewing angle: 55.4 degree wide to 2.9 degree (tele)
   f) Preset positions: 6 minimum
   g) RS-232 controllable
   h) Min Illumination: .5 lux in high sensitivity mode, 1.7 lux normal mode
   i) Video output: HD-SDI
   j) Camera model: EVIH100S by Sony or equal by Panasonic or Canon. Provide 2. Color must be black, mounts must be black.

b. System shall support a multi-site feature to allow participants from various sites to join videoconference.
   1) LifeSize Room 220 Embedded HD Multipoint Control Unit
   Full HD CP MCU with up to 4 visible
   participants
   2) Up to 8-way 720p60/ 720p30/ 6-way 1080p30 CP or VAS mode
   Full HD / SD Transcoding support
   3) Virtual Multiway allows participant viewing control
   4) H.239 multipoint support shared from any participant
   5) Disable multipoint option

c. System shall allow for computer input to be displayed to all video call participants. Computer input shall include MS Office applications, and web browsing.
   1) Native H.239 dual stream support for Computer Input and dual stream workflow
   2) H.261, H.263, H.263+, H.264 and H.239 compliant
   3) 1 x DVI-I In (HDMI/VGA enabled)
   4) Platform Agnostic – MAC/PC/Linux – all applications, simply computer share
   5) Utilize V6 input to AV switcher for PC audio and video routing to teleconferencing system as well as room projector and sound system.

d. System shall optimize audio programming to make participants sound as if they are located in the same room.

e. System shall support the call when the ISDN or network line is lost so call does not have to be redialed, or system rebooted. System shall support analog phone calls.

f. System must support video streaming
   1) Web browsers supported:
   IE 7, Firefox 3.5, Google Chrome 4.0, Safari 4 or later with Adobe Flash
   Player 10 or later
   2) Streaming Capabilities:
      a) Live and on demand streaming (Unicast)
      b) Up to 1000 live 720p30 HD viewers

c) User Access Control
d) Security-based profiles include administrator, content creator, authorized viewer, and anonymous viewer. Define video access by individual user and group

3) Recording Capabilities (system shall provide recording for teleconferences)
a) Records audio, video (up to 720p30), and data
b) Dynamically captures video and data, no pre- configuring is required
c) Capture all participants in a call (both near and far end)
d) Auto-publishing support with a recording key
e) Recording indicator overlay is only visible during the live call, not present in the recorded video
f) Synchronized video, audio, and data playback, play, pause, forward, rewind, volume, full screen

4) Content Management
a) Organize content by channels
b) Video metadata includes: Title, Description, Author, Tags, Date

g. Rack mountable (1U)

h. Provide and install Streaming/Recording via LifeSize Video Center:
a) Supported Uses:
Record/stream outside of a call
Record/stream point to point or multipoint calls
Capture all call participants
Independently capture both primary and secondary video
Single button, ad-hoc recording
Live streaming and on demand playback
Recording and archiving when recording is completed
b) Video and Audio Format:
High Definition, 16:9 aspect ratio
H.264 video, AAC-LC audio
Flash Video Player

i. Other features:
Dynamic user controlled playback layout
Locking faceplate bezel
System Management
FTP backup to network storage
Incremental backup tool
System restore capability
Firmware update tool
Enable/disable video download capability

j. System shall be fully integrated to room control system.
a) 1 x DB-9 RS-232 port configurable to Room Control System

k. System video (Local and Remote) shall be distributed to room matrix switcher for distribution to LCD projector, TV Monitors, interactive projector and external feed ports.

l. Provide Lifesize 220 and any options to provide recording of all teleconferences or equal by Cisco or Tandberg

12. Assistive Listening System
a. The stationary FM transmitter shall be capable of broadcasting on 57 channels.
b. The transmitter shall have a SNR of 80dB or greater.
c. The output power shall be adjustable to quarter, half or full.
d. Channel tuning shall be capable of being locked.
e. The device shall broadcast on both wide and narrow band channels.
f. The device shall have an audio frequency response of 50Hz to 15KHz, +/- 3dB at 72MHz, or of 50Hz to 10kHz, +/- 3dB at 216MHz.

g. It shall have two mixing audio inputs. The device shall have the following audio controls: input level, process control and an adjustable low pass shelving filter.
h. Provide appropriate antenna, and rack mounting kit. Provide all rigging, amplifiers, cables, and equipment to mount antennas to the back wall at the projector location. Ensure full room coverage. Coordinate antenna placements with Architect.
i. Provide 5 programmable receivers (Listen Technologies LR-500 or equal) with earbuds and rechargeable batteries, and two transformer/wall chargers.
j. System is the Listen LT-800, Phonic Ear, Williams Sound or equal.

13. Video/Audio Transmitter/Receiver
    a. Provide and install a video and audio transmitter as designated V6 on the drawings.
        1) Unit shall transmit high resolution video (1900 x 1200) over Cat 5 type twisted pair cables.
        2) HDMI and composite video, audio input to sound system
        3) Unit shall mount in a decora style faceplate as shown on the drawings.
        4) Include power supply
        5) Route the audio to the Student Dining sound system.

        Transmitter unit is MTP/HDMI UTAD by Extron or equal equal by Crestron or Kramer.
    b. Provide and install a video and audio receiver at the rack.
        1) The receiver unit shall receive high resolution video (1900 x 1200) and mono audio signals 600 feet or more over a signal Cat 5 type cable.
        2) The receiver shall support RGBHV, RGBS, RGsB, RsGsBs, component video, S-Video, HDMI and composite video.
        3) Unit shall incorporate skew compensation adjustments for each color
        4) Include power supply.
        5) Connect video of receiver to input on AV switcher. Provide and install input on AV switcher.

        Receiver unit is MTP/HDMI UR by Extron or equal by Crestron or Kramer.
14. Equipment Rack
    a. Provide 19” Equipment Rack installed in closet designated on drawings. Mount all audio mixing, source (except for DVD, CD and wireless microphones), and speaker equipment in rack. Size rack to fit all equipment provided based on vendors actual equipment selection. Provide a storage drawer in rack for microphones and cabling.
    b. Provide a patch bay in rack for two XLR inputs from owner provided sound effect mixers. One input shall be labeled “upper speakers” (four total) and the DSP shall be programmed to mix this input with other audio for presentation over the upper balcony speakers. The other input shall be labeled “lower speakers” and the DSP shall be programmed to mix this input with other audio for presentation over the lower under balcony speakers (four total). Intent is to allow a mixer to be used to send various owner provided content direct to the individual speakers if desired.
    d. Provide and install cooling unit in equipment rack
    e. Provide 19” equipment rack sized to fit cabinet on first floor. Install DVD player, CD/iPod player and wireless microphones in this rack, cabled back to the main rack on balcony.
15. Cabling – Provide and install:
    a. Provide for a complete and operational system, similar to classroom connectivity, to include all cables required for desired form and function stated above.
    b. Provide and install 24AWG or heavier HDMI cable with 6’ of slack from V6 location to the outside of the cabinet. 4’ shall extend from the cabinet when

connected to the HDMI input on the V6 plate. 2" conduits will be provided from cabinet to sound closet on 2nd floor.

c. Provide and install cabling from video switcher to receiver unit at projector located in the rear of the room.
d. Provide and install cabling to connect receiver output to projector at rear of room.
e. Provide and install cat6A patch cord for projector to be connected to data outlets.
f. Provide 25' VGA cable with 3.5mm audio. Store in cabinet of first floor.
g. Provide and install inputs for DSP and AV switcher for IPTV STB connection in rack. IPTV STB to be provided by Owner and installed by 277000 subcontractor. Coordinate testing and programming with 277000 subcontractor.
h. Any other cabling, equipment or devices required for a complete and operational system

16. Microphones, Stands, Cords
    a. Provide :
        1) 4 microphones of type Peavey PVM46 or equal by Shure or Crown
            a) Diamond-coated diaphragm
            b) Neodymium iron boron magnet
            c) Hyper-cardioid polar pattern
            d) 15 dB (typical) front to back rejection
            e) 400 ohms, balanced
            f) 45 Hz - 16 kHz frequency response
            g) Ultra-high sensitivity (-51 dB)
            h) 140 dB maximum SPL
            i) Black rubberized paint finish
            j) Swivel adapter
            k) Protective pouch
        2) 4 microphone stands
        3) 4 microphone cords, 25'
17. IPTV Set Top Box (STB)
    a. IPTV STB (provided by Owner, installed by 277000). Locate in EQ Sound rack in sound closet. Video and audio shall be connected to video switcher inputs and audio system. Touch panel control system shall include icon and programming to present IPTV on projector screen and over the sound system. STB output shall be viewable on the room projector.

2.4 Gymnasium

A. General:

1. Gymnasium shall be equipped with a local sound reinforcement system with the ability to separate program distribution to a full gym configuration, two one half-gymnasium configuration, and one-half with separation of remaining one-quarter and one-quarter into two distinct program areas, divided by the room division screens.
2. Room separation control shall be located in closet as designated on the drawings.
3. Speakers shall be hung or mounted in permanent locations. Speakers shall not be mounted where damage may occur.
4. Provide adequate speaker coverage for floor areas. Coverage area shall provide a clear signal to bleacher area and gymnasium floor.
5. 8 Channel Sound mixing console and audio program equipment shall be installed within a 19" wall mount cabinet.
6. Wireless touch panel control system. Provide dock for wireless touch panel in rack.
7. Crowd noise in a high school gymnasium can easily reach 90 dBA or more during the course of a sporting event. Installers shall plan for a minimum signal/noise (10

dB) and plan for an amplifier/speaker combination that should be capable of continuous operation at 100 dB in audience areas.

8. Provide flexible antennas where possible. Use trusses to protect all antenna placements where possible from accidental or intention gym equipment impact.
9. Place all speakers considering gym equipment placements to avoid obstructions to audio discernment. See related work in the beginning of the specification.
10. This specification is designed to define the desired operating criteria and suggested equipment. Communications subcontractor shall design and provide a fully operational system including labor, materials, and equipment including all wall plates.

B. Capabilities:

1. The system shall provide the following capabilities:
   a. Ability to distribute program and live audio sources to the gym as defined in A.1 above.
   b. Ability to use wireless touch panel from anywhere in the gym to control audio sources.
2. System must provide intelligible sound to the audience despite a great deal of crowd noise. Communications subcontractor shall design and install a distributed system to provide even coverage.

C. Products:

1. Digital Signal Processors (Minimum 1, provide in quantities required for design intent)
   a. Provides a fixed configuration of 12 inputs (min) and 8 outputs (min), configurable signal processing and a high bandwidth, fault tolerant digital audio bus.
   b. It has open architecture which is fully configurable through HiQnet™ London Architect. A rich palette of processing and logic objects and a “drag and drop” method of configuration provide a simple and familiar design environment.
   c. The processor features a low latency, fault tolerant digital audio bus of 48 channels which uses standard Category 5e cabling giving a distance of 100m between compatible devices. Fiber media converters can be used to increase the distance between devices to over 40km.
   d. Analog Inputs provide software configurable gain in 6dB steps up to +48dB per channel and software selectable Phantom Power per channel.
   e. Phantom Power, Signal Present and Clip information per channel is easily accessible, without the requirement for a PC, from clear front panel LED indication. A bi-directional locate function allows devices to be identified both from and within HiQnet London Architect.
   f. 12 Control Inputs and 6 Logic Outputs integrate with GPIO compatible devices.
   g. Key Features:
      1) 12 Analog Inputs (min) (with 48v Phantom Power per Channel)
      2) 8 Analog Outputs (min)
      3) Configurable Signal Processing
      4) Rich Palette of Processing and Logic Objects
      5) 48 Channel, Low Latency, Fault Tolerant Digital Audio Bus
      6) Clear Front Panel LED Indication
      7) Bi-Directional Locate Functionality
      8) 12 Control Inputs and 6 Logic Outputs for GPIO integration

9) Technical Specifications:

1. Front Panel Led Indicators:
   a. Per Input: Signal Present, CLIP, 48V (Input only)
   b. Other: COM, STAT, ERR, PWR
2. Analog Inputs: 12 electronically balanced on Phoenix Combicon removable screw connectors
   a. Mic/Line Inputs:
      i. Nominal gain 0dB, electronically switchable up to +48dB,in +6dB steps
   b. Input Impedance:
      i. 3.5kΩ
   c. Maximum Input Level:
      i. +20dBu with 0dB input gain,+8dBu with 12dB gain
   d. CMRR:
      i. >75dB at 1KHz
   e. Input Noise (E.I.N.):
      i. <-128dBu typical with 150Ω source
   f. Phantom Power:
      i. 48V nominal, selectable per input
   g. A/D Latency:
      i. 37/Fs [0.77ms@48k]
3. Analog Outputs: 8 (min) electronically balanced on Phoenix/Combicon removable screw connectors
   a. Maximum Output Level: +19dBu
   b. Frequency Response:
   c. 20Hz-20KHz (+0.5dB/-1dB)
   d. THD: <0.01% 20Hz to 20KHz, +10dBu output
   e. Dynamic Range:108dB typical, 22Hz-22KHz unweighted
   f. Crosstalk: <-75dB
   g. Output Impedance: 40Ω balanced and 20 Ω unbalanced
   h. D/A Latency: 29/Fs [0.60ms@48k]
4. Control Ports: 12 inputs and 6 outputs
   a. Control Input Voltage: 0 to 4.5v
   b. Control Input Impedance: 4.7kÙ to +5V (2-wire mode), >1MÙ (3-wire mode)
   c. Logic Output Voltage: 0 or +5V unloaded
   d. Logic Output Impedance: 440 Ω
   e. Logic Output Current: 10mA source, 60mA sink
5. Watchdog Output: Phoenix/Combicon connector for failsafe control
   a. Opto Output Current: 14mA maximum
   b. Withstanding Voltage: 80V maximum (Off)
   c. Series Impedance: 220 Ω (isolated)
6. Control Network:
   a. Connectors: RJ45 Ethernet connector

b. Maximum Cable Length: 100m/300ft on Category 5 cable between device and Ethernet switch

7. BLU link:
   a. Connectors: 2 x RJ45 Ethernet connectors
   b. Maximum Cable Length: 100m/300ft on Category 5e cable between devices
   c. Max. Number of Nodes: 60
   d. Latency: 11/Fs [0.23ms@48k]
   e. Pass Through Latency: 4/Fs [0.08ms@48k]
8. Power and Dimensions:
   a. Mains Voltage: 100-240V AC, 50/60Hz
   b. Power Consumption: <55VA
   c. BTU Rating: <188 BTU/hr
   d. Operating Temp. Range: 5 (41) to 35 (95) degrees C (degrees F)
   e. Dims: (H x W x D): 1.75" (1U) x 19" x 9.0" (45mm x 483mm x 229mm)
   f. Weight: 6.4 lbs / 2.9 Kgs

Digital Signal Processor shall be the BSS Audio BLU-100 and BLU-BOB2 and/or BLU-BIB as necessary or equal by Biamp Audia Flex or Soundweb.

2. Carousel-type 5 CD Changer + AM/FM Tuner Combination Unit
   a. The 5 CD Changer + AM/FM Tuner shall provide output terminals for both RCA and XLR connections.
   b. Provide three modes of CD playback. All disc random play, disc sequential random play, or program random play.
   c. CD can play a single selection, or continuous play.
   d. AM/FM Tuner shall have a 30 station random present memory.
   e. AM/FM Tuner shall support radio data system functions included in carrier signals.
   f. Display screen shall display AM/FM program service name, and current time.
   g. Unit shall be rack mounted and RS-232 controllable
   h. This item may be submitted as two units if rack space allows, provided they meet the above specification

   5 CD Changer- AM/FM Tuner Combination Unit manufacturer is Denon or equal by Tascam or Marantz.
3. Wireless Microphone Systems- Provide five (5)
   a. Power On Indicator
   b. “RF” Diversity Signal Indicators
   c. Transmitted (TX) Audio Indicators
   d. Receiving Antenna Indicator
   e. Group/Channel Displays
   f. Transmitter Battery Life Indicator
   g. MODE Button for Menu Display
   h. SET Button for Saving Settings
   i. Mic/Line level Switch
   j. XLR and ¼” outputs with level control
   k. Provide rack mounting kit, and mount in equipment cabinet.
   l. Provide 1 handheld microphone, 1 lav mic and one headworn

microphone/transmitter combination on the same frequency. Devices will not be used concurrently.

m. Model is the Shure ULXS4 Standard, with Rack Mounting Kit or equal by Sennheiser or Electro-Voice

4. CD iPod Dock Combination Unit – provide 2
   a. Plays audio CDs, MP3 CDs and WAV file CDs
   b. Provide output terminals for both RCA and XLR connections
   c. Dock connector for Apple iPod charging and playback
   d. iPod video playback from S-video or composite output
   e. CD TEXT and ID3 tag support
   f. Continue, Random and Program play modes
   g. Repeat All and Repeat Single play modes
   h. Index Search
   i. Shock/skip prevention memory buffer
   j. ±12% pitch control (analog outputs only)
   k. RCA unbalanced line outputs (CD and iPod)
   l. Coaxial and Optical S/PDIF digital out (CD only)
   m. 1/4" stereo headphone output
   n. 2u rack mountable
   o. Wireless 55-key remote control
   p. 19"W x 3.72" H x 11.73"D
   q. Each unit may be assigned to different gyms/speakers as a source. Provide selection on touch panel.

   CD/ iPod dock is a Tascam CD-200i or equal by Denon or Marantz
5. Microprocessor controlled Matrix Switcher- 8 inputs x 8 outputs
   a. Provide a broadcast quality matrix/routing switcher capable of switching multiple audio sources. Provide for 8 input sources and 8 output sources.
   b. System shall be capable of being expanded by adding modules and flashing firmware. System shall not require to be sent back to factory to update.
   c. Balanced and unbalanced stereo audio.
   d. Adjustable input gain/attenuation (adjustable via RS-232/422). Allow for settings between –15dB to +9dB.
   e. Complete audio breakaway will allow for separate audio signals from the video signal to switch either video only, or audio only. Allows for audio follow on one or all channels.
   f. Unit must support full control via RS-232/422 for connection into integrated touch panel control system.
   g. Unit shall be rack mountable in a 19” equipment rack, 2U.
   h. Inputs to the matrix switcher shall be from:
      1) All Microphone Jacks (including Gym Track and Floor area)
      2) Combination CD/iPod x2
      3) 5 CD/AM & FM Combination Unit
      4) Spare Input, Rack mounted RCA input.
      5) IPTV Set Top Box audio
   i. Outputs from the matrix switcher shall be to:
      1) Amplifier for Speaker Assembly whole gym
      2) Amplifier for Speakers (1/2 gym)
      3) Amplifier for Speakers (1/2 gym)
   j. Microprocessor controlled matrix switcher is Extron model 60-658AX or equal by Crestron or Kramer.
6. Assistive Listening System
   a. The stationary FM transmitter shall be capable of broadcasting on 57 channels.

b. The transmitter shall have a SNR of 80dB or greater.
c. The output power shall be adjustable to quarter, half or full.
d. Channel tuning shall be capable of being locked.
e. The device shall broadcast on both wide and narrow band channels.
f. The device shall have an audio frequency response of 50Hz to 15KHz, +/- 3dB at 72MHz, or of 50Hz to 10kHz, +/- 3dB at 216MHz.
g. It shall have two mixing audio inputs. The device shall have the following audio controls: input level, process control and an adjustable low pass shelving filter.
h. Provide appropriate antenna, and rack mounting kit.
i. Provide 38 programmable receivers (Listen Technologies LR-500 or equal) with earbuds and rechargeable batteries, and 38 transformer/wall chargers.
j. Provide 25 programmable receivers (Listen Technologies LR-500 or equal) with LA-166 Neck Loop lanyards and rechargeable batteries, and 25 transformer/wall chargers.
k. Listen LT-800, Phonic Ear, Williams Sound or equal.

7. Amplifiers (Qty 5 min)
   a. Provide amplifiers sized as necessary to provide 95-100 dbSPL to the audience area with even coverage based on specific speaker selection.
   b. Mount all amplifiers in equipment rack in sound control closet.
   c. Provide and install five (5) Bose PM8500 each with a PMESP link card, assigning speakers to amps to provide for speaker groupings of ½ by ½, ¼ by ¼ by ½ and full gym. See T2.9.
   d. Twenty eight (28) RMU108 speakers shall be arranged such that two speakers are on a bridged channel. See T2.9.
   e. Each subwoofer shall have two (2) bridged channels (one driving each speaker within the subwoofer). See T2.9.
   f. Provide and install a ControlSpace CC-64 with CC-PS1 power supply.
   g. Provide and install an ESP1240 processor with Ethernet card.
   h. Provide and install all switching required in port densities required.
   i. Amplifiers are by Bose or equal by Crown International, CT Series, Crest or Hafler
8. Speakers
   a. Speakers shall be flown from gymnasium trusses. Subs shall be above trusses.
   b. Provide and install 28 Bose RMU108 speakers. Provide a distributed speaker system as shown on the drawings (SPr locations). Speakers shall be installed at 10 degree angles in the direction indicated by the arrows on the speaker symbol. The waveguide shall be rotated 90 degrees in all RMU108 speakers such that the dispersion pattern is 60 degree horizontal and 90 degree vertical.
   c. Provide three (3) Subwoofers where shown on the drawings (SPr2).
   d. Distributed speakers are Bose RMU108 or equal by EAW KF Series Loudspeakers or Reinkus Heinz.
   e. Subwoofers are Bose RMS215 or equal by EAW or Reinkus Heinz
   f. All speakers shall be white. All rigging and mounting hardware shall be provided and installed.
   g. Provide and install protective wire guards for all RMU108 speakers.
9. Integrated Room Control System
   a. Provide a wireless touch panel based integrated control system with wireless gateway equipment (provide equipment for wireless touch panel functionality from any location in room). Provide charging dock in rack for touch panel.

b. Provide network streamer, CEN-NVS200 or equal by Extron or Atlona.
c. Provide PoE switch, connect to network streamer.
d. Provide wireless access point to broadcast network stream in room. Connect to PoE switch. Position WAP for 100% room coverage of the wireless touch panel. Coordinate antenna/wap location with architect.
e. 8.4” Wireless WiFi Touch Panel

Features

8.4” active matrix touch screen display

b) 800 x 600 SVGA display resolution
c) 16 bit Isys i/O graphics
d) Synapse image rendering algorithm
e) 802.11a/b/g Wi-Fi 2-way wireless communications
f) Windows XP Embedded operating system
g) Onboard PC applications for Web browsing, streaming media, conferencing, VoIP, and remote desktop
h) Wireless video from network cameras and servers
i) Built-in microphone and stereo speakers
j) 5-way thumbpad and 4 "Softkey" buttons
k) Includes stylus with onboard storage slot
l) Built-in biometric fingerprint scanner
m) Built-in Bluetooth technology
n) Internal Li-Ion battery pack included

SPECIFICATIONS

a) Touch Screen Display
b) Display Type
   1.TFT Active matrix color LCD
c) Size
   1. 8.4 inch (305 mm) diagonal
d) Aspect Ratio
   1.4:3 SVGA
e) Resolution
   1. 800 x 600 pixels
f) Brightness
   1. 200 nits (cd/m²)
g) Contrast
   1. 500:1
h) Color Depth
   1. 18-bit, 262k colors
i) Illumination
   1. Edgelit fluorescent
j) Viewing Angle
   1. ±65° horizontal, +65° / -45° vertical
k) Touch Screen
   1. Resistive membrane
l) Buttons & Indicators

1. 4 softkey
2. Programmable 5 way thumbpad (4-way plus center ENTER button
3. 2 programmable up/down pushbuttons

m) Communications
   1. RF Transceiver
      a. IEEE 802.a/b/g Wi-Fi, 5 or 2.4GHz 2-way RF
   2. Bluetooth
      a. Bluetooth V1.2 Class 1 built in

n) Video
   a. MPEG4 & MJPEG

o) Audio
   1. Dual onboard microphones
   2. Builtin speakers
   3. Stereo headphone out

8.4" Wireless Touch Panel is Crestron TPMC-8XGA or equal by AMX or Extron

f. System shall control the following devices:
   1) 5 CD changer, Power and Transport
   2) CD/iPod Unit x2, Power and Transport Controls
   3) DSP Audio Switcher
   4) Gym speaker selection (quarter by quarter by half; half by half; full
   5) AM/FM tuner

g. Provide and install a graphical user interface to control and switch all devices above. Owner must approve screen design prior to system programming.

h. Touch panel shall be integrated with fire alarm control panel. Upon fire alarm activation, touch panel shall flash the word FIRE in red on the screen and all audio sources shall be muted. Electrical subcontractor shall supply the source, communications subcontractor of this section shall install override and test capability. All audio sources shall be muted upon PA system activation. 275000 communications subcontractor to provide source, communications subcontractor of this section shall install override and test capability.

i. Provide controller that is Ethernet capable for touch panel. Provide all power supplies and related equipment for a fully functional system in accordance with design intent. Crestron Pro 2 with C2ENET-2 card or equal by AMX or Extron.

10. Equipment Rack
    a. Provide 1 (One) 44 Space metal equipment rack (Middle Atlantic ERK 4425 or equal by Sanus or Peerless) with locking door in sound closet. Provide rack mounted power strips as necessary to power rack equipment.
    b. Provide and install cooling unit in equipment rack.
    c. Provide and install RCA L&R audio jacks on a rack plate and provide and install an audio input for this connection to the DSP.
11. Microphones, Stands, Cords
    a. Provide :
       1) Six (6) microphones of type Peavey PVM46 or equal by Shure or Crown
          a) Diamond-coated diaphragm
          b) Neodymium iron boron magnet
          c) Hyper-cardioid polar pattern
          d) 15 dB (typical) front to back rejection
          e) 400 ohms, balanced

f) 45 Hz - 16 kHz frequency response
g) Ultra-high sensitivity (-51 dB)
h) 140 dB maximum SPL
i) Black rubberized paint finish
j) Swivel adapter
k) Protective pouch

2) 6 microphone stands
3) 6 microphone cords, 25'
4) 2 Microphone cords, 50'
5) 2 microphone deskstands with mounting adapter

2.5 Student Dining

A. General:

1. Student Dining room shall have a wall mounted rack audio cabinet, and program speakers to provide even audio coverage throughout the room. System shall provide 45db minimum above background noise.
2. Multi-Channel mixer (12 inputs and 8 outputs) and amplifier shall have a mute function to mute all audio channels, and deliver program source from building intercom system if all call is made. Provide components required to mute sound system. Input provided by 27 50 00 communications subcontractor, coordinate requirements. Provide components required to mute system upon fire alarm activation. Electrical subcontractor shall provide source, communications subcontractor of this section shall cable and install overrides and test.
3. System shall have a wireless microphone system with headphone and hand held units.
4. Video projector with long throw lens and IR transmitter/emitter system (IP symbol) for projector and STB control
5. This specification is designed to define the desired operating criteria and suggested equipment. Communications subcontractor shall design and provide a fully operational system including labor, materials, and equipment, cabling, terminations and wall plates.

B. Capabilities:

1. The system shall provide the following capabilities:
   a. Ability to deliver audio programming material evenly throughout the room.
   b. Ability to display IPTV (IPTV STB provided by Owner, installed by 277000), local computer/laptop, and other sources on the projector. Long throw lens shall cover the full screen.
   c. Rack mounted components with a lockable front cover.

C. Products:

1. Mixer and Amplifier - rack mounted
   a. The amplifier shall meet the following performance criteria:
      1. Power output shall be min 500W, 01% THD at 1k Hz
      2. Frequency response shall be +/- 1 dB from 20 Hz to 20 kHz
      3. Outputs: 70v.
      4. 2 channels (250w x 2)
      5. Provide a rack mount bracket

      Amplifier is model DA-250DH by TOA or equal by Architectural Acoustics, Bose or equal.
   b. The mixer shall have mixer input ports and shall be capable of operation from a 110/120 V, 50/60 Hz line.
   c. Each input port (12 inputs) and output port (8 outputs) of the mixer shall be usable with modules.
   d. Plug-in accessory modules designed for use with the mixer/power amplifier shall

utilize the latest in surface mount component technology and include microphone, line, and special function models.

e. Provide a rack mount bracket.
f. Unit must be equipped to mute current audio program if building PA system is activated. PA system communications subcontractor (27 50 00) to provide program source; communications subcontractor of this section to install override. Provide control module. Provide module to mute audio when fire alarm system is activated.
g. Provide microphone input modules for all microphone jacks (wired and wireless)
h. Provide balanced line input modules. Provide quantities so each source can be mixed independently for audio sources (to include IPTV set top box, cd/ipod, AM/FM tuner, 5 cd changer, a PC audio input, AM/FM tuner and a dual RCA input plate (provide plate) on the front of the rack for auxiliary input.
i. Provide processor module(s) for speakers; min 4 output, one output to TV studio via R2 plate, (provide cable and connection to R2 plate) Provide output for assistive listening system.
k. Provide additional amplification as necessary to provide desired SPL levels to area, based on the number of installed speakers.

Mixer shall be model D901 by TOA, Allen and Heath, Bose or equal.

2. Carousel-type 5 CD Changer + AM/FM Tuner Combination Unit
   a. The 5 CD Changer + AM/FM Tuner shall provide output terminals for both RCA and XLR connections.
   b. Provide three modes of CD playback. All disc random play, disc sequential random play, or program random play.
   c. CD can play a single selection, or continuous play.
   d. AM/FM Tuner shall have a 30 station random present memory.
   e. AM/FM Tuner shall support radio data system functions included in carrier signals.
   f. Display screen shall display AM/FM program service name, and current time.
   g. Unit shall be rack mounted.
   h. This item may be submitted as two units if rack space allows, provided they meet the above specification

   5 CD Changer - AM/FM Tuner Combination Unit is by Denon, Marantz, Tascam or equal.

3. CD iPod Dock Combination Unit
   a. Plays audio CDs, MP3 CDs and WAV file CDs
   b. Provide output terminals for both RCA and XLR connections
   c. Dock connector for Apple iPod charging and playback
   d. iPod video playback from S-video or composite output
   e. CD TEXT and ID3 tag support
   f. Continue, Random and Program play modes
   g. Repeat All and Repeat Single play modes
   h. Index Search
   i. Shock/skip prevention memory buffer
   j. ±12% pitch control (analog outputs only)
   k. RCA unbalanced line outputs (CD and iPod)
   l. Coaxial and Optical S/PDIF digital out (CD only)
   m. 1/4" stereo headphone output
   n. 2u rack mountable
   o. Wireless 55-key remote control
   p. 19"W x 3.72" H x 11.73"D

   CD/ iPod dock is a Tascam CD-200i or equal by Marantz or Denon.

4. Wireless Microphone System
   a. Power On Indicator
   b. “RF” Diversity Signal Indicators

c. Transmitted (TX) Audio Indicators
d. Receiving Antenna Indicator
e. Group/Channel Displays
f. Transmitter Battery Life Indicator
g. MODE Button for Menu Display
h. SET Button for Saving Settings
i. Mic/Line level Switch
j. XLR and ¼" outputs with level control
k. Provide rack mounting kit, and mount in equipment cabinet.
l. Provide 1 handheld microphone, and one lapel microphone/transmitter combination on the same frequency. Devices will not be used concurrently.

Model is the Shure ULXS4 Standard, with Rack Mounting Kit or equal by ElectroVoice, Sennheiser or equal.

5. Rack mounted jacks
   a. Provide the following jacks at the front of the equipment rack:
      1) One (1) RCA pair connection (Audio left/right) input connected to line level input jack on input module.
6. Equipment Racks
   a. Provide 19" Equipment Rack wall mounted installed in closet designated on drawings. Mount all audio mixing, source, and speaker equipment in rack. Size rack to fit all equipment provided based on vendors actual equipment selection. Rack shall have lockable front door.
7. Speakers
   a. The loudspeaker shall be a 6.5" co-axial type, ported bass-reflex design, sealed enclosure suitable for pendant and ceiling mounting with an external appearance that is aesthetically pleasing and blends well with surrounding building architecture and fixtures.
   b. Loudspeakers requiring visible external mounting brackets shall not be acceptable. Provide appropriate mount and brackets for locations shown on the drawings. Recessed speakers in tile shall be white. Pendant speakers shall be black and hung such that the bottom of the speaker is just above the ceiling grid assembly. None of the speaker shall protrude below the open ceiling grid.
   c. The loudspeaker shall have a smooth frequency response from 62Hz to 20kHz (recessed type) and 58Hz to 18kHz for the pendant type.
   d. The output sound pressure level at a distance of 1 meter with 1 W of input power applied shall be 108 dB SPL min.
   e. The rated power handling (Continuous Program) shall be 100W (recessed type) and 150W pendant type.
   f. The loudspeaker shall be compatible with low and high impedance speaker systems and shall include a built-in 70/100 V matching transformer with the following selectable tap settings min:
      1) 7.5W, 15W, 30 W (70 V). Set all taps to 30W.
   g. The loudspeaker shall include a removable terminal block connector, screw terminal type, with loop-through terminations and accept AWG #14 - #24.
   h. An internal protection circuit shall prevent damage to components in an overload condition. Once activated, the circuit shall reduce the input signal and reset automatically after approximately thirty seconds once overload condition is removed.
   i. The loudspeaker grille material shall be a paintable white finish for recess mount speakers and black for pendant mount speakers.
   j. Provide tile bridges as necessary.
   k. Provide ceiling mounted recess loudspeakers in designated SPr locations on the drawings, Control 16C/T by JBL or equal (Qty 6) and pendant mount loudspeakers where shown on the drawing, installed above the open ceiling

grid, where shown on the drawings, Control 67P/T by JBL or equal (qty 6).

8. Video Projector with Mount (A minimum 10,500 ANSI lumens video projector with long throw lens (must fully fit screen)).
   a. Vertical and horizontal lens shift and digital keystone correction shall provide picture-perfect placement of image.
   b. Input compatibility ranges from analog and digital RGB data up to UXGA resolution and video sources from composite through 1080i HDTV.
   c. Intelligent lens system
   d. Specifications
      1) Brightness, 10,500 lumens min
      2) Contrast Ratio: 2500-10,000:1 full on/off; 650:1 ANSI (typ)
      3) Resolution: Native WUXGA 1920 x 1200, 3 chip DLP
      4) 90% brightness uniformity
      5) Dynamic Scaling: Digital scaling of resolutions Digital De-interlacing Technology of STV, DTV, and HDTV formats (DDT) with 2:3 pull-down
      6) Horizontal Frequency: 15 to 120kHz
      7) Vertical Frequency: 24 to 150Hz
      8) Pixel Clock: 165MHz
      9) Projection Lens: Provide long-fixed lens sized to fit projection screen listed in Division 11.
      10) Digital keystone correction
      11) Accepts all current HDTV/DTV formats (VGA to QXGA)
      12) Auto-Setup
      13) Comprehensive color adjustment
      14) Multi-standard video decoder
      15) Horizontal and vertical scaling all inputs
      16) Offsets: +/- 112% vertical; +/- 54% horizontal
      17) Modular Inputs required:
          Dual link DVI
          Twin HDMI
          Analog
          Ethernet / LAN (provide and install patch cord to data jack at projector location)
          RS-232
          Other inputs needed for submitted design
      18) Outputs:
          Two built-in speakers
          Stereo audio loop-through
   e. Provide and install on ceiling mount at location specified on drawings approximately 30’ away from screen. Mount projector from ceiling (include pole mount) as close to the ceiling as possible using lens shift but not keystone correction to achieve full image on screen. Provide anti-vibration mount if image vibration is observed. General contractor shall provide blocking required for proper safe installation. Coordinate blocking required with general contractor.
   f. Provide appropriate lens for full screen display at installed distance.

g. Connect IPTV STB (provided by Owner, installed by 277000 subcontractor) to projector input. Provide audio out from STB at projector to sound system as an input via V7 faceplate to allow STB audio to be presented over the sound system. Provide appropriate input module in mixer. Provide audio amplifier if required. Coordinate with 277000 subcontractor.

h. Projector model is Christie WU12K-M WUXGA DLP projector with long throw lens or equal by Infocus or Mitsubishi.

9. Video/Audio Transmitter/Receiver

a. Provide and install a video and audio transmitter as designated V6 on the drawings.
   1) Unit shall transmit high resolution video (1900 x 1200) over Cat 5 type twisted pair cables.
   2) HDMI and composite video, audio input to sound system
   3) Unit shall mount in a decora style faceplate as shown on the drawings.
   4) Include power supply
   5) Route the audio to the Student Dining sound system.

   Transmitter unit is MTP/HDMI UTAD by Extron or equal equal by Crestron or Kramer.

b. Provide and install a video and audio receiver at the projector as shown on the drawings.
   1) The receiver unit shall receive high resolution video (1900 x 1200) and mono audio signals 600 feet or more over a signal Cat 5 type cable.
   2) The receiver shall support RGBHV, RGBS, RGsB, RsGsBs, component video, S-Video, HDMI and composite video.
   3) Unit shall incorporate skew compensation adjustments for each color
   4) Include power supply.
   5) Connect video of receiver to input on projector.

   Receiver unit is MTP/HDMI UR by Extron or equal by Crestron or Kramer.

10. Additional Cables – provide and install:

a. Cat6 data cable for IPTV STB

b. Cat6 data cable to Lan port on projector

c. Provide 6' VGA and HDMI cables and 6' 3.5mm audio cable for laptop connection to submitted audio connection for V6 to route audio from laptop to sound system rack.

11. Provide and install IR receiver and emitter for the projector. Install IR receiver at IP symbol location in the Café, route emitter to projector via pole mount and blank ports on V7. Test and verify performance.

12. Microphones, Stands, Cords

Provide :

a. 2 microphones of type Peavey PVM46 or equal by Crown or Shure
   1) Diamond-coated diaphram
   2) Neodymium iron boron magnet
   3) Hyper-cardioid polar pattern
   4) 15 dB (typical) front to back rejection
   5) 400 ohms, balanced
   6) 45 Hz - 16 kHz frequency response
   7) Ultra-high sensitivity (-51 dB)
   8) 140 dB maximum SPL
   9) Black rubberized paint finish
   10) Swivel adapter
   11) Protective pouch

b. 2 microphone stands

c. 2 microphone cords, 25'

13. Assistive Listening System

a. The stationary FM transmitter shall be capable of broadcasting on 57 channels.
b. The transmitter shall have a SNR of 80dB or greater.
c. The output power shall be adjustable to quarter, half or full.
d. Channel tuning shall be capable of being locked.
e. The device shall broadcast on both wide and narrow band channels.
f. The device shall have an audio frequency response of 50Hz to 15KHz, +/- 3dB at 72MHz, or of 50Hz to 10kHz, +/- 3dB at 216MHz.
g. It shall have two mixing audio inputs. The device shall have the following audio controls: input level, process control and an adjustable low pass shelving filter.
h. Provide appropriate antenna, and rack mounting kit.
i. Provide 5 programmable receivers (Listen Technologies LR-500 or equal) with earbuds and rechargeable batteries, and two transformer/wall chargers.
j. Listen LT-800, Phonic Ear, Williams Sound or equal.

2.6 PE Alternative

A. General:
1. Room shall have a wall mounted rack audio cabinet, and program speakers to provide even audio coverage throughout the room. System shall provide 45db minimum above background noise.
2. Multi-Channel mixer (12 inputs, 8 outputs) and amplifier shall have a mute function to mute all audio channels, and deliver program source from building intercom system if all call is made. Provide components required to mute sound system. Input provided by 27 50 00 communications subcontractor, coordinate requirements.
3. System shall have a wireless microphone system with headphone and hand held units.
4. This specification is designed to define the desired operating criteria and suggested equipment. Communications subcontractor shall design and provide a fully operational system including labor, materials, and equipment, cabling, terminations and wall plates.
5. System shall be muted upon fire alarm activation. Provide and install equipment to accomplish this function. Fire alarm input provided by electrical subcontractor.

B. Capabilities:
1. The system shall provide the following capabilities:
   a. Ability to deliver audio programming material evenly throughout the room.
   b. Rack mounted components with a securable front cover.

C. Products:
1. Mixer and Amplifier - rack mounted (Provide 1)
   a. The amplifier shall meet the following performance criteria:
      1. Power output shall be 240 W, 01% THD at 1k Hz
      2. Frequency response shall be +/- 1 dB from 20 Hz to 20 kHz (direct output) and 20 Hz to 15 kHz +/- 1dB (transformer output) and 20Hz-20kHz +1dB/ -3dB (transformer output).
      3. Inputs: 1 modular input port, 1 direct input.
      4. Outputs: Main transformer: 8 ohms, 25v, 70v, balanced. Direct: 4 ohms, unbalanced.
      5. Provide a rack mount bracket

      Amplifier is model P924MK2 by TOA or equal by Bose or Architectural Acoustics
   b. The mixer shall have mixer input ports and shall be capable of operation from a

110/120 V, 50/60 Hz line.

c. Each input port (12 inputs) and output port (8 outputs) of the mixer shall be usable with modules.
d. Plug-in accessory modules designed for use with the mixer and power amplifier shall utilize the latest in surface mount component technology and include microphone, line, and special function models.
e. Provide a rack mount bracket.
f. Unit must be equipped to mute current audio program if building PA system is activated and if fire alarm is activated. PA system communications subcontractor (27 50 00) to provide program source; electrical subcontractor to provide fire alarm control panel input; communications subcontractor of this section to install overrides. Provide control modules.
g. Provide microphone input modules for all microphone jacks (provide wired and wireless inputs)
h. Provide balanced line input modules. Provide in quantities so each source can be mixed independently for audio sources (cd/ipod, AM/FM tuner, 5 cd changer, and a dual RCA input plate (provide plate) on the front of the rack for auxiliary input).
i. Provide processor module(s) for speakers.
k. Provide additional amplification as necessary to provide desired SPL levels to area, based on the number of installed speakers.

Mixer shall be model D901 by TOA, Allen and Heath, Bose or equal.

2. Carousel-type 5 CD Changer + AM/FM Tuner Combination Unit (Provide 1)
   a. The 5 CD Changer + AM/FM Tuner shall provide output terminals for both RCA and XLR connections.
   b. Provide three modes of CD playback. All disc random play, disc sequential random play, or program random play.
   c. CD can play a single selection, or continuous play.
   d. AM/FM Tuner shall have a 30 station random present memory.
   e. AM/FM Tuner shall support radio data system functions included in carrier signals.
   f. Display screen shall display AM/FM program service name, and current time.
   g. Unit shall be rack mounted.
   h. This item may be submitted as two units if rack space allows, provided they meet the above specification

   5 CD Changer - AM/FM Tuner Combination Unit manufacturer is Denon or equal by Tascam or Marantz.
3. CD iPod Dock Combination Unit (Provide 1)
   a. Plays audio CDs, MP3 CDs and WAV file CDs
   b. Provide output terminals for both RCA and XLR connections
   c. Dock connector for Apple iPod charging and playback
   d. iPod video playback from S-video or composite output
   e. CD TEXT and ID3 tag support
   f. Continue, Random and Program play modes
   g. Repeat All and Repeat Single play modes
   h. Index Search
   i. Shock/skip prevention memory buffer
   j. ±12% pitch control (analog outputs only)
   k. RCA unbalanced line outputs (CD and iPod)
   l. Coaxial and Optical S/PDIF digital out (CD only)
   m. 1/4" stereo headphone output
   n. 2u rack mountable
   o. Wireless 55-key remote control
   p. 19"W x 3.72" H x 11.73"D

   CD/ iPod dock is a Tascam CD-200i or equal by Denon or Marantz.
4. Wireless Microphone System

a. Power On Indicator
b. “RF” Diversity Signal Indicators
c. Transmitted (TX) Audio Indicators
d. Receiving Antenna Indicator
e. Group/Channel Displays
f. Transmitter Battery Life Indicator
g. MODE Button for Menu Display
h. SET Button for Saving Settings
i. Mic/Line level Switch
j. XLR and ¼” outputs with level control
k. Provide rack mounting kit, and mount in equipment cabinet.
l. Provide 1 handheld microphone, and one lapel microphone/transmitter combination on the same frequency. Devices will not be used concurrently.
Model is the Shure ULXS4 Standard, with Rack Mounting Kit or equal by Electro-Voice or Sennheiser

5. Rack mounted jacks
   a. Provide the following jacks at the front of the equipment rack:
      1) One (1) RCA pair connection (Audio left/right) input connected to line level input jack on module.
      2) Provide 1 XLR input cabled to a microphone input of the system
6. Equipment Racks (Provide 1)
   a. Provide 19” wall mounted equipment rack, installed in closet designated on drawings. Mount all audio mixing, source, and speaker equipment in rack. Size rack to fit all equipment provided based on communications subcontractor’s actual equipment selection. Rack shall have lockable front door.
7. Speakers (Provide at all SPr symbols, Qty 8)
   a. The loudspeaker shall be a 6.5” co-axial type, ported bass-reflex design, sealed enclosure suitable for wall or ceiling mounting with an external appearance that is aesthetically pleasing and blends well with surrounding building architecture and fixtures.
   b. Loudspeakers requiring visible external mounting brackets shall not be acceptable. Provide appropriate mount and brackets for locations shown on the drawings. Speaker shall be white.
   c. The loudspeaker shall contain a diffuser to provide 110 degree conical dispersion.
   d. The loudspeaker shall have a smooth frequency response from 62Hz to 20k Hz.
   e. The output sound pressure level at a distance of 1 meter with 1 W of input power applied shall be 108 dB SPL.
   f. The rated power handling (Continuous Program) shall be 100 W (8 ohms)
   g. The loudspeaker shall be compatible with low and high impedance speaker systems and shall include a built-in 70/100 V matching transformer with the following selectable tap settings:
      1) 7.5W, 15W, 30 W, (70 V). Set tap at 15w.
   h. The loudspeaker shall include a removable terminal block connector, screw terminal type, with loop-through terminations and accept AWG #14 - #24.
   i. An internal protection circuit shall prevent damage to components in an overload condition. Once activated, the circuit shall reduce the input signal and reset automatically after approximately thirty seconds once overload condition is removed.
   j. The loudspeaker grille material shall be a paintable white finish.
   k. Provide ceiling mounted loudspeakers in designated SPr locations on the drawings.

   Loudspeakers shall be JBL model Control 16C/T, Bose, EAW or equal

8. Microphones, Stands, Cords
   a. Provide:
      1) Microphone of type Peavey PVM46 or equal by Shure or Crown
      2) Diamond-coated diaphram
      3) Neodymium iron boron magnet
      4) Hyper-cardioid polar pattern
      5) 15 dB (typical) front to back rejection
      6) 400 ohms, balanced
      7) 45 Hz - 16 kHz frequency response
      8) Ultra-high sensitivity (-51 dB)
      9) 140 dB maximum SPL
      10) Black rubberized paint finish
      11) Swivel adapter
      12) Protective pouch
   b. Microphone stand
   c. Microphone cord, 25'

2.7 Storage/Support Facility ALTERNATE - 2

A. General:
   1. Equipment to be installed in ERK4425 rack provided by 271000. Room F101 shall have program speakers to provide even audio coverage throughout the room. System shall provide 45db minimum above background noise.
   2. Multi-Channel mixer (12 inputs, 8 outputs) and amplifier shall have a mute function to mute all audio channels, and deliver program source from building intercom system if all call is made. Provide components required to mute sound system. Input provided by 27 50 00 communications subcontractor, coordinate requirements.
   3. System shall have a wireless microphone system with headphone and hand held units.
   4. This specification is designed to define the desired operating criteria and suggested equipment. Communications subcontractor shall design and provide a fully operational system including labor, materials, and equipment, cabling, terminations and wall plates.
   5. System shall be muted upon fire alarm activation. Provide and install equipment to accomplish this function. Fire alarm input provided by electrical subcontractor.

B. Capabilities:
   1. The system shall provide the following capabilities:
      a. Ability to deliver audio programming material evenly throughout the room.
      b. Rack mounted components.

C. Products:
   1. Mixer and Amplifier - rack mounted (Provide 1)
      a. The amplifier shall meet the following performance criteria:
         1. Power output shall be 240 W, 01% THD at 1k Hz
         2. Frequency response shall be +/- 1 dB from 20 Hz to 20 kHz (direct output) and 20 Hz to 15 kHz +/- 1dB (transformer output) and 20Hz-20kHz +1dB/ -3dB (transformer output).
         3. Inputs: 1 modular input port, 1 direct input.
         4. Outputs: Main transformer: 8 ohms, 25v, 70v, balanced. Direct: 4 ohms, unbalanced.
         5. Provide a rack mount bracket

         Amplifier is model P924MK2 by TOA or equal by Bose or Architectural Acoustics
      b. The mixer shall have mixer input ports and shall be capable of operation from a 110/120 V, 50/60 Hz line.

c. Each input port (12 inputs) and output port (8 outputs) of the mixer shall be usable with modules.
d. Plug-in accessory modules designed for use with the mixer and power amplifier shall utilize the latest in surface mount component technology and include microphone, line, and special function models.
e. Provide a rack mount bracket.
f. Unit must be equipped to mute current audio program if building PA system is activated and if fire alarm is activated. PA system communications subcontractor (27 50 00) to provide program source; electrical subcontractor to provide fire alarm control panel input; communications subcontractor of this section to install overrides. Provide control modules.
g. Provide microphone input modules for all microphone jacks (provide wired and wireless inputs)
h. Provide balanced line input modules. Provide in quantities so each source can be mixed independently for audio sources (cd/ipod, AM/FM tuner, 5 cd changer, and a dual RCA input plate (provide plate) on the front of the rack for auxiliary input).
i. Provide processor module(s) for speakers.
k. Provide additional amplification as necessary to provide desired SPL levels to area, based on the number of installed speakers.
Mixer shall be model D901 by TOA, Allen and Heath, Bose or equal.

2. Carousel-type 5 CD Changer + AM/FM Tuner Combination Unit (Provide 1)
   a. The 5 CD Changer + AM/FM Tuner shall provide output terminals for both RCA and XLR connections.
   b. Provide three modes of CD playback. All disc random play, disc sequential random play, or program random play.
   c. CD can play a single selection, or continuous play.
   d. AM/FM Tuner shall have a 30 station random present memory.
   e. AM/FM Tuner shall support radio data system functions included in carrier signals.
   f. Display screen shall display AM/FM program service name, and current time.
   g. Unit shall be rack mounted.
   h. This item may be submitted as two units if rack space allows, provided they meet the above specification
   5 CD Changer - AM/FM Tuner Combination Unit manufacturer is Denon or equal by Tascam or Marantz.
3. CD iPod Dock Combination Unit (Provide 1)
   q. Plays audio CDs, MP3 CDs and WAV file CDs
   r. Provide output terminals for both RCA and XLR connections
   s. Dock connector for Apple iPod charging and playback
   t. iPod video playback from S-video or composite output
   u. CD TEXT and ID3 tag support
   v. Continue, Random and Program play modes
   w. Repeat All and Repeat Single play modes
   x. Index Search
   y. Shock/skip prevention memory buffer
   z. ±12% pitch control (analog outputs only)
   aa. RCA unbalanced line outputs (CD and iPod)
   bb. Coaxial and Optical S/PDIF digital out (CD only)
   cc. 1/4" stereo headphone output
   dd. 2u rack mountable
   ee. Wireless 55-key remote control
   ff. 19"W x 3.72" H x 11.73"D
   CD/ iPod dock is a Tascam CD-200i or equal by Denon or Marantz.
4. Wireless Microphone System
   a. Power On Indicator

b. “RF” Diversity Signal Indicators
c. Transmitted (TX) Audio Indicators
d. Receiving Antenna Indicator
e. Group/Channel Displays
f. Transmitter Battery Life Indicator
g. MODE Button for Menu Display
h. SET Button for Saving Settings
i. Mic/Line level Switch
j. XLR and ¼” outputs with level control
k. Provide rack mounting kit, and mount in equipment cabinet.
l. Provide 1 handheld microphone, and one lapel microphone/transmitter combination on the same frequency. Devices will not be used concurrently.
Model is the Shure ULXS4 Standard, with Rack Mounting Kit or equal by Electro-Voice or Sennheiser

5. Rack mounted jacks
   a. Provide the following jacks at the front of the equipment rack:
      1) One (1) RCA pair connection (Audio left/right) input connected to line level input jack on module.
      2) Provide 1 XLR input cabled to a microphone input of the system
6. Speakers (Provide at all SPr, Qty 9)
   a. The loudspeaker shall be a 6.5” co-axial type, ported bass-reflex design, sealed enclosure suitable for pendant mounting with an external appearance that is aesthetically pleasing and blends well with surrounding building architecture and fixtures.
   b. Loudspeakers requiring visible external mounting brackets shall not be acceptable. Provide appropriate pendant mount and brackets for locations shown on the drawings. Speaker shall be white.
   c. The loudspeaker shall have a smooth frequency response from 58Hz to 18k Hz.
   d. The output sound pressure level at a distance of 1 meter with 1 W of input power applied shall be continuous 109 dB SPL, peak 115 dB.
   e. The rated power handling (Continuous Program) shall be 150 W (8 ohms)
   f. The loudspeaker shall be compatible with low and high impedance speaker systems and shall include a built-in 70/100 V matching transformer with the following selectable tap settings:
      1) 7.5W, 15W, 30 W, 60W (70 V). Set tap at 15W.
   g. The loudspeaker shall include a removable terminal block connector, screw terminal type, with loop-through terminations and accept AWG #14 - #24.
   h. The loudspeaker grille material shall be a paintable white finish.
   i. Provide pendant mounted loudspeakers in designated SPr locations on the drawings.

   Loudspeakers shall be JBL model C67P/T-WH, Bose, EAW or equal
7. Microphones, Stands, Cords
   a. Provide:
      1) Microphone of type Peavey PVM46 or equal by Shure or Crown
      2) Diamond-coated diaphram
      3) Neodymium iron boron magnet
      4) Hyper-cardioid polar pattern
      5) 15 dB (typical) front to back rejection
      6) 400 ohms, balanced
      7) 45 Hz - 16 kHz frequency response
      8) Ultra-high sensitivity (-51 dB)
      9) 140 dB maximum SPL
      10) Black rubberized paint finish

11) Swivel adapter
12) Protective pouch

b. Microphone stand
c. Microphone cord, 25'

2.8 TV – Studio Area

A. General:

1. Provide an intercom system for TV Studio Production communication.
   a. The intercom main station shall be a single-rack-space, solid state, rack-mountable unit.
   b. It shall support two channels of intercom, providing power to remote stations and belt packs as well as supplying a full-duplex audio signal path.
   c. Both channels shall operate independently, or may be linked together via a Channel A/B link switch.
   d. Each channel shall provide call signaling to its intercom line, and shall have a dual-action electronic momentary/latching talk button.
   e. The main station shall provide both visual and audible alerts when receiving an incoming call signal.
   f. The main station shall allow monitoring of intercom activity on one or both channels from either an internal speaker or a headset attached to a front-panel connector, with a frequency response of 200 Hz to 18 kHz, +/-2 dB. Volume controls shall be provided for each channel.
   g. Voice communications from the station shall originate from either a headset microphone or an optional gooseneck mic, via front-panel connectors. Voice frequency response shall be 250 Hz to 12 kHz, contoured for intelligibility, and the circuit shall include a limiter with a 20-dB range.
   h. The main station shall have a single, line-level program input with a program level control.
   i. Each channel shall have a program on/off/interrupt switch and a program-send level control, with a frequency response of 150 Hz - 18 kHz, +/-2 dB.
   j. The main station shall provide separate "announce out" and "relay out" circuits and connectors, activated by a front-panel button.
   k. A global "remote mic kill" function, activated by a front-panel button, shall be capable of muting all open microphones on both intercom channels.
   l. The main station shall supply an output current of 2.0 amperes, maximum, with an output voltage of 30 VDC. It shall have the caAuditoriumity to power up to 60 headset or 20 speaker stations, spread over one or two intercom channels. Channel A shall have the capability of providing up to the full 2.0 amperes of current, and Channel B shall have the capability of providing up to 1.75 amperes of current.
   m. The main station shall have a residual hum and noise level of <-80 dBv.
   n. Both channels shall have independent electronic short-circuit protection, with a "short" indicator LED. In the event of a short on one channel, the other channel shall maintain operation. Either or both channels shall be capable of recovering from a short at full load. Reset time from a short circuit shall be less than seven seconds.
   o. Each channel output shall consist of two paralleled male 3-pin XLR connectors. Each channel shall have a switchable 200-ohm termination. Rear-mounted option switches shall be provided, enabling or disabling the Momentary Talk, Call On Talk, IFB Interrupt, and Announce Interrupt functions for each channel.
   p. The unit's input power supply shall be a universal switching type with post

regulators and individual reset circuitry for each channel. It shall operate from 90 - 240 VAC, 50 - 60 Hz, at 60 watts maximum, and shall connect to the external power source through an 3-conductor IEC connector.

q. Provide 8 intercom base units (Clear Com RS-501 Headset Belt Packs or equal by Telex or Production Intercom)

r. Provide 8 ClearCom CC-95 Headsets or equal by Telex or Production Intercom

s. Install base controller in rack located in Control room.

t. Main station unit is ClearCom MS-702 or equal by Telex or Production Intercom

2. Wire 2 of the 4 RCA connections on S2 to the S1 plate in recording studio area for program audio monitor. Wire other 2 RCA connections on S2 plate to control room S1 plate for audio monitor.

3. Wire B3 HDMI cables to the control room and terminate on custom rack plate in rack with HDMI connectors. Captivate all HDMI connections.

4. Provide three RG6 cables with F connections from at all B2 locations run to head end coiled 25' and terminated with F connections in cable tray.

5. Owner will coordinate CATV provider to provide 2 DEMARCS for CATV service. One in MDF (where the service entrance is located) for the IPTV system, and one in TV Control Room or Head End for Public Access use.

6. Terminate V8 cabling from various locations in the school to control room rack on custom plates. Label all jacks appropriately.

2.9 Band & Choral Rooms

A. General:

1. Cable all microphones in each space as noted on drawings.

2. The portable rack must be complete and outfitted with all necessary cables to record. Wiring to include two (2) 8 Channel XLR snakes (1 in each room) to route audio from wall plates at mic collection points to the mixing board.

3. Rooms receive all equipment listed for a standard classroom

B. Portable Recording Station

1. Audio Mixer System (Provide 1 in each room at mic collection point)
Provide a 19" rack mountable mixer. Mixer must provide 8 mono inputs to a stereo mix output. For ease of installation, the connector section must be in a rotatable pod. Mixer is Soundcraft GB2R or equal by Peavey or Pyle.

2. Solid State Recorder (Provide 1 in each room)

a. Record Directly to Compact Flash Cards.

b. Web control of all functions (schedule recordings, record, setup and file transfer to PC). Provide patch cable and connect to data outlet.

c. 24 bit recording

d. No Moving parts

e. MP3, MP2, WAV and BWF format compatible

f. Must have Ethernet capability for network operation

g. Unit shall be mounted in the rack.

h. Each unit shall be connected to the Mixer, as a recording device.

i. Provides Automatic archiving of recorded files to the network

j. Provide patch cord to connect unit to local D1 faceplate

k. Product is Marantz PMD 580 or equal by Denon or Marantz

3. 10 x 6 Space Rack for Mixer (Provide 1 in each room)
Rack must have a slant top to allow for 16 Channel Mixer to be installed
Mixer must also have at least 6RU available on the front portion of the rack.
Rack must have locking door covers.
Rack must be constructed lightweight for portability
Rack is Gator type 10X6.

4. Amplifier and Speakers (Provide 1 amplifier and 4 speakers (at SPr2 locations), in each room)
   a. Amplifier shall be installed in teacher builtin cabinet (T1/T4).
      1) 200w 70v amplifier, Extron model 60-850-01 or equal by Crown or Crest.
   b. Provide cable to split audio output of PC (coordinate with owner).
      1) One output to voice amplification system, other to amplifier.
   c. Provide 4 ceiling speakers in each room, Shown as SPr2.
      1) Speakers are 100w, 65Hz-16kHz, tapped at 50w.
      2) Speakers shall be Bose DS100F, white, or equal by TOA or JBL.

5. 15 Amp Power Strip (Provide 1 in each room)
   a. Differential and common mode and spike protection required.
   b. Unit must be 19" Rack mountable
   c. Unit must have 8 rear outlets
6. Hanging Microphones
   a. Hanging microphones shall be wired to the location noted on the drawings.
   b. Wide dynamic range
   c. Frequency response: 50Hz to 17 KHz
   d. Impedance: 150 ohms balanced
   e. SNR: 66dB at 94 dB SPL
   f. Operating voltage: Phantom power 11 to 52 VDC, pos voltage on pins 2 relative to pin 3 of output connector.
   g. Finish: Black, include black windscreen
   h. Include power supply if required.

   Hanging microphones (HM on drawings) shall be model MX202 by Shure or equal by Crown or Samson. Provide any other equipment for hanging microphones to function.
7. Microphones, Stands, Cords
   Provide :
   a. Sixteen (16) (8 in band, 8 in chorus) microphones of type Peavey PVM46 or equal by Crown or Shure
      1) Diamond-coated diaphragm
      2) Neodymium iron boron magnet
      3) Hyper-cardioid polar pattern
      4) 15 dB (typical) front to back rejection
      5) 400 ohms, balanced
      6) 45 Hz - 16 kHz frequency response
      7) Ultra-high sensitivity (-51 dB)
      8) 140 dB maximum SPL
      9) Black rubberized paint finish
      10) Swivel adapter
      11) Protective pouch
   b. 16 (8 in band, 8 in chorus) microphone stands
   c. 16 (8 in band, 8 in chorus) microphone cords, 25'

2.10 Press Box
   A. PA System
      1. The PA system shall include a mixer/amplifier combination unit or separate mixer and amplifier assemblies.
         a. 8 mic and 2 line inputs min

b. Min 3 band eq
c. 48 volt phantom power
d. Freq response: 25 Hz to 20 kHz min
e. 4 line outs min
f. THD +N dBu: <0.2
g. 600W per channel @ 4 ohms, minimum
h. Provide an output to the R2 in the pressbox to send audio to the TV Studio.

Equipment is Bose control space processor (ESP-00), QSC (GX5s) power amplifiers, ControlSpace CC-64 Control Center, ControlSpace input/output cards and power supplies in quantities required for design intent. Install equipment in a portable rack enclosure .

2. Provide speakers in sufficient quantities (min of 6) to provide full coverage of field. Mount three 2 speaker cluster speakers to upper fencing of pressbox using uni-strut (SPrx2 in three locations on T2.4)
   a. Include all mounting, poles, and rigging hardware
   b. Speakers must be weather resistant
   c. Speakers shall be full range 2 way
   d. Speakers shall be black
   e. 12” neodymium magnet water resistant woofer
   f. 400W program power handling min in 8 ohm mode
   g. Titanium diaphragm compression driver tweeter
   h. Molded plastic enclosure
   i. Horn coverage pattern: 60 degrees by 60 degrees

   Bose Panaray 802 III loudspeaker or equal
3. Microphones, Stands, Cords

   Provide :
   a. 2 microphones of type Shure SM58S with protective pouch or equal
   b. 2 microphone deskstands with microphone adapter
   c. 2 microphone cords, 25’ of type Whirlwind MK or equal
   d. In portable rack:
      1) 1 Mipro wireless handheld microphone (ACT-707H) and body pack transmitter (ACT-707TM)
      2) 1 Mipro wireless headworn microphone (HS-09BGC) and body pack transmitter (ACT-707TM).
      3) Provide antenna booster (AD-707B), and antennas AD-707A) to provide for coverage to far side of field.
      4) Provide Mipro dual wireless mic receiver (ACT-707DE).
4. Install equipment in rack provided by 271000 (ERK4425)
   a. 271000 equipment shall be installed at the top of the rack
   b. Door must be able to be closed and locked. Adjust rails for equipment accordingly.
   c. Include a drawer for cabling and micropones
   d. Provide and install a sequential power strip
   e. Provide and install a mic plate on the rack front with 5 xlr connections for connecting 2 wired mics to be used inside the press box. XLR jacks shall be inputs to the PA system. Other 3 connections shall be for cross connecting the field mics to the system.
   f. provide and install an XLR connection marked PA override. Provide PA override signal from school and terminate with XLR connector. Connect PA over ride signal to system. Ensure input from override XLR shall mute all audio sources.
   g. Provide cross connect rack panel bringing the field mics to the front of the rack (3 XLR), and providing mic inputs to the system on the 5 mic input plate mentioned above.

h. Provide rack plates/mounts for equipment in rack.

5. Provide CD/iPod dock combination unit in portable rack as provided elsewhere on project. Tascam model CD-200i. Connect to sound system.
6. Assistive Listening System, install in rack.
   a. The stationary FM transmitter shall be capable of broadcasting on 57 channels.
   b. The transmitter shall have a SNR of 80dB or greater.
   c. The output power shall be adjustable to quarter, half or full.
   d. Channel tuning shall be capable of being locked.
   e. The device shall broadcast on both wide and narrow band channels.
   f. The device shall have an audio frequency response of 50Hz to 15KHz, +/- 3dB at 72MHz, or of 50Hz to 10kHz, +/- 3dB at 216MHz.
   g. It shall have two mixing audio inputs. The device shall have the following audio controls: input level, process control and an adjustable low pass shelving filter.
   h. Provide appropriate antenna, and rack mounting kit.
   i. Provide 5 programmable receivers (Listen Technologies LR-500 or equal) with earbuds and rechargeable batteries, and transformer/wall chargers.
   j. System is the Listen LT-800, Phonic Ear, Williams Sound or equal.
7. Provide and install 3 XLR mic inputs around the 50 yard line in the field box provided by 271000 under the bleachers to a rack plate on the front of the press box sound system. Label “Mics From Field”
8. Provide 3 XLR patch cords to connect the field mics terminated on the front of the rack from the field to the 5 xlr mic input plate to present the field mics on the PA system of the press box.
9. Provide and install on a rack plate on the front of the press box an XLR mix output connection from the sound system. Label “Mix Out”. This is to be used by the TV studio personnel who are sending mixed audio over their fiber transceivers.
10. Provide and install 3 intercom jacks and cable them inside the field box to a rack plate on the front of the press box sound rack, as terminated elsewhere on the project. Label jacks “Int From Field”
11. Provide and install 3 video, audio and bidirectional audio fiber transmitters and 3 receivers. Mount transmitters below fiber patch panel in Press box. Mount Receivers below fiber patch panel in TV control room. Provide breakout cables to connect mics and intercoms to the fiber transmitters and receivers breakout cables. Provide 3 HD-3500-FMX-37-ST transmitters and 3 HD-3500-FMX-73-ST receivers. Provide 2 triple RNT mount kits. Provide 6 breakout cables, DVMXLR35.

2.11 Audio Visual Cabling

A. General:

1. The following types of signal cables shall be used on this project:
   a. #24 AWG Audio Microphone Cable
   b. Special intercom cabling- 2pair #22 AWG for Intercom Systems
   c. Audio Wire / Speaker Cabling #14 AWG for Speakers
   d. Analog Multi-Pair Snake Cable- 4, 8 & 12 Pair
   e. RGB Bundled Cable- 3 & 5 Conductor
   f. Precision analog/digital video cable- RG/59/U Video Snake Cable
   g. 4-Pair Cat 6 for equipment controls and video transmission - Gray
2. TERMINATION HARDWARE: The following types of connectors shall be used on this project
   a. XLR Connectors- 4 Position Neutrick # NC4FDL-1 or equal
   b. XLR Connectors- 3 Position Neutrick or equal
   c. Category 6 Data/Voice Jacks, (must be Gray) Panduit Mini-Com series, Siemon, or equal

d. BNC Connector Jack, Panduit Mini-Com series, Siemon, or equal
e. RCA Connectors
f. S-Video connectors (if required)
g. VGA connectors
h. USB connectors (if required)

B. Category 6 Cable 4-Pairs- Equipment Controls
1. The Category 6 cable shall use the color code indicated below:
a. All Category 6 cable for Equipment Control shall be Gray.
b. Colored tape may not be used to re-identify jacket color.
2. The cable shall be composed of 24-gauge bare solid copper conductors bonded pairs, ripcord. Cable shall be insulated with a marked (every 2 ft) polyethylene vinyl chloride jacket. There shall be no shield required in the sheath.
3. Each sheath shall contain 4 unshielded copper twisted pairs. Each pair shall have a different twist ratio per foot ranging from 12 to 24 twists per foot.
4. The cables shall meet or exceed the following standards:
a. ANSI/TIA/EIA-568-B.2-1 “Commercial Building Telecommunications Cabling Standard” Horizontal Cabling Section.
b. IEEE 802.3
c. ICEA 580-576.
d. Canadian Standards Association IWC FT4.
e. National Electric Code - Article 800.
f. Proposed ANSI X3T9.S requirements for UTP at 100 Mbps and 155 Mbs ATM.
g. Cable manufacturer must be ISO-9002 Certified.
h. Cable Color:
1) Equipment Control — Gray.
i. Patch Cable Color
1) Equipment Control — gray.
j. Maximum operating voltage- 300V RMS
k. Nom. Capacitance @1 kHz- 15 pF/ft
l. Nom. Velocity of Propagation- 70%
5. In addition to complying with the above listed standards, all Category 6 cables shall meet or exceed the following criteria:
a. Testing shall be in accordance with procedures in the referenced standards unless otherwise stated.
b. All cables shall meet, as a minimum, the requirements of:
1) CSA
2) NEC
3) UL444
4) ANSI/TIA/EIA-568-B Category 6
5) ISO/IEC 11801 Category 6
c. Factory splices of the insulated wire are not allowed in any portion of the cable, Butt-welded conductors prior to insulating are permitted.

C. 24 AWG Audio Microphone Cable
1. The cable shall be black. Colored tape may not be used to re-identify jacket color.
2. The cable shall be composed of a 2 #24 AWG tinned copper conductors, and a PVC Exterior jacket.
3. Cable shall contain a tinned copper braid shield, and have a rubber insulation jacket.
4. The cables shall meet or exceed the following standards:
a. Underwriters Laboratory
b. National Electric Code

c. Cable manufacturer must be ISO-9002 Certified

5. Cable shall meet the following performance specifications:
   a. Temperature Rating- -30 to + 60 deg C
   b. Continuous current per conductor- 5.2 Amps
   c. Structural Return Loss- 5-1000MHZ, 20DB Min
   d. Maximum Operating Voltage- 350v RMS
   e. Normal Conductor DC Resistance @ 20deg C- 6.8 Ohms / 1000'
   f. Normal Shield DC Resistance @ 20deg C- 2.7 Ohms / 1000'
   g. Normal impedance- 50 Ohms
   h. Normal inductance- .19 Micro H/ Ft
6. The cable is Belden Wire and Cable, #1503 or equal

D. Special Intercom Cabling- 2 Pair #22 AWG
1. The cable shall be black. Colored tape may not be used to re-identify jacket color.
2. The cable shall be composed of a 2 pairs (4 conductor) #22 AWG tinned copper conductors, and a polypropylene insulation jacket. Individual pairs shall have a poly vinyl chloride (PVC) insulation jacket.
3. Cable shall contain an individual overall aluminum foil polyester tape shield.
4. The cables shall meet or exceed the following standards:
   a. Underwriters Laboratory- 1581 Flame Resistance
   b. National Electric Code
   c. UL Type CM
   d. AWM 2717
   e. Cable manufacturer must be ISO-9002 Certified
5. Cable shall meet the following performance specifications:
   a. Temperature Rating- -20 to +80 deg C
   b. Maximum Continuous current per conductor @ 25deg C- 2.3 Amps
   c. Maximum Operating Voltage- 300v RMS
   d. Normal inductance of pairs- .18 Micro H/FT
   e. Normal capacitance between conductor of pair @ 1KHZ- 35 PF/FT
   f. Normal capacitance conductor to shield- 62 PF/FT
   g. Normal Conductor DC Resistance @ 20deg C- 17 Ohms / 1000'
   h. Normal Shield DC Resistance (pair) @ 20deg C- 16.6 Ohms / 1000'
   i. Normal impedance- 50 Ohms @ 1 MHZ
6. Pair Color:
   a. Pair One- Black/Red
   b. Pair Two- White/Green
7. The cable is Belden Wire and Cable, #8728 or equal.

E. Audio Wire / Speaker Cabling #14 AWG
1. The cable shall be black. Colored tape may not be used to re-identify jacket color.
2. The cable shall be composed of a 4 #14 AWG stranded (104x34) bare copper conductors with anti-corrosion treatment.
3. Cable shall have a poly vinyl chloride insulation, unshielded, and a polyvinyl chloride jacket.
4. The cables shall meet or exceed the following standards:
   a. Underwriters Laboratory
   b. National Electric Code
   c. Cable manufacturer must be ISO-9002 Certified
5. Cable shall meet the following performance specifications:
   a. Temperature Rating- -20 to +60 deg C
   b. Maximum continuous current per conductor- 9.5 Amps
   c. Maximum Operating Voltage- 300v RMS
   d. Maximum Conductor DC Resistance @ 20deg C- 2.7 Ohms / 1000'

e. Normal inductance- .20 Micro H/ Ft

6. Color Pairs
   a. The conductor colors shall be black, red, white and green.
7. The cable is Belden Wire and Cable, #1810A or equal.

F. Analog Multi-Pair Microphone Snake Cable
1. The cable shall be black. Colored tape may not be used to re-identify jacket color.
2. The cable shall be composed of the specified number of paired conductors called for on the plans and contract documents. Cable shall be #24 AWG tinned copper conductors, with a #18 AWG stranded tinned copper drain wire.
3. Cable shall contain an individual overall aluminum foil polyester tape shield with 100% shield coverage. An individual polyvinyl chloride jacket shall enclose individual pairs.
4. Pair color code shall be black and red.
5. The cables shall meet or exceed the following standards:
   a. Underwriters Laboratory
   b. National Electric Code
   c. CEC Type CMR FT4
   d. Cable manufacturer must be ISO-9002 Certified
   e. Cable shall meet the following performance specifications:
      1) Temperature Rating- -30 to + 75 deg C
      2) Continuous current per conductor- 1.05 Amps
      3) Maximum Operating Voltage- 300v RMS
      4) Normal capacitance between conductor of pair @ 1KHZ- 31 PF/FT
      5) Normal capacitance conductor to shield- 58 PF/FT
      6) Normal Conductor DC Resistance @ 20deg C- 22 Ohms / 1000'
      7) Normal Shield DC Resistance (pair) @ 20deg C- 18.9 Ohms / 1000'
      8) Normal impedance- 50 Ohms @ 1 MHZ
6. The cable is
   a. 4 Pair Snake Cabling- Belden Wire and Cable #1408R or equal.
   b. 8 Pair Snake Cabling- Belden Wire and Cable #1410R or equal.
   c. 12 Pair Snake Cabling- Belden Wire and Cable #1411R or equal.
   d. 16 Pair Snake Cabling- Belden Wire and Cable #1412R or equal.

G. RGB Bundled Cable- 3 & 5 Conductor #26 AWG
1. The cable shall be black. Colored tape may not be used to re-identify jacket color.
2. The cable shall be composed of the specified number of conductors called for on the plans and contract documents. Cable conductors shall be #26 AWG bare copper conductors with polyethylene insulation.
3. The cable shall contain a bonded aluminum foil-polyester tape-aluminum foil shield, plus tinned copper braid shield with 93% shield coverage. An individual polyvinyl chloride jacket shall surround cable.
4. Color code shall be red, green, blue, white, yellow (5 conductor); red, green, blue (3 conductor).
5. The cables shall meet or exceed the following standards:
   a. Underwriters Laboratory- UL 1354, & UL -2668
   b. National Electric Code
   c. CEC Type CMR FT4
   d. Cable manufacturer must be ISO-9002 Certified
6. Cable shall meet the following performance specifications:
   a. Temperature Rating- -40 to + 60 deg C
   b. Normal Capacitance- 17.3 PF/FT
   c. Maximum Operating Voltage- 300v RMS
   d. Structural Return Loss- 25DB MIN, 10-40 MHZ

e. Normal Conductor DC Resistance- 41.5 Ohms / M Ft
f. Normal Shield DC Resistance- 8.6 Ohms / M FT.
g. Normal impedance- 50 Ohms @ 1 MHZ

7. The cable is
   a. 5 Conductor- Belden Wire and Cable #1418B or equal.
   b. 3 Conductor- Belden Wire and Cable #1164B or equal.

H. HDMI cables shall all be a min of 24AWG (26AWG and thinner is not acceptable)

I. RG11, 75 Ohm Solid 14AWG
1. The coaxial cable must be black. Colored tape may not be used to re-identify jacket color.
2. The cable shall be composed of a solid 14 AWG bare copper conductor insulated with gas injected foam high density polyethylene, surrounded by a Polyethylene jacket. Cable shall be RG/11/u
3. Cable shall have a bare copper braid shield (97% coverage).
4. The cables shall meet or exceed the following standards:
   a. EU CE Mark
   b. National Electric Code- CATV or CM Rating
   c. UL-1581 Flame Test Rating
   d. Cable manufacturer must be ISO-9002 Certified
5. Cable shall meet the following performance specifications:
   a. Conductor diameter: .064”
   b. Impedance: 75 Ohms
   c. Attenuation, Max:

1 MHZ- .2 DB/100’	10MHZ- .4 DB/100’
50MHZ- .9 DB/100’	100MHZ- 1.3 DB/100’
200MHZ- 1.9 DB/100’	400MHZ- 2.9 DB/100’
700MHZ- 4.1 DB/100’	900MHZ- 4.8 DB/100’
1000MHZ- 5.2 DB/100’	

   d. Structural Return Loss- 5-450MHZ, 23DB
   e. Maximum Operating Voltage- 600v RMS
   f. Normal Conductor DC Resistance @ 20deg C- 2.6 Ohms / 1000’
   g. Normal Shield DC Resistance @ 20deg C- 1.1 Ohms / 1000’
6. The cable is Belden Wire and Cable, Model 8213 or equal. Provide from MDF plywood backboard at CATV demark location to TV Head End plywood back board. Leave terminated and coiled 25’ in each area.

2.13 Termination Hardware

A. Modular 8 position modules: (Equipment control)
1. Termination hardware shall be designed with an integral locking mechanism, which upon insertion of a modular plug provides maximum pullout strength at the plug/jack interface.
2. All modular 8-position jacks shall be RJ-45, T 568B wired.
3. The jacks shall meet or exceed the following standards:
   a. ANSI/TIA/EIA-568-B.2-1 Commercial Building Telecommunications Cabling
   b. Standards, Category 6
   c. IEC 60603-7
   d. FCC Part 68, Subpart F
4. The modular jacks shall meet the following electrical performance and certification requirements:
   a. The modular jacks shall meet all ANSI/TIA/EIA-568-B Commercial Building Telecommunications Cabling Standards and ANSI/TIA/EIA-568-B.2
   b. Near End Crosstalk (NEXT) and Attenuation measurements shall be made

per ANSI/TIA/EIA-568-B.2-1 and ANSI/TIA/EIA-568-B.2.

5. The modular jacks shall meet the following requirements:
   a. Connector-insulation displacement connectors shall be capable of accepting 24 gauge AWG solid conductor wire.
   b. Terminated in accordance with EIA-568B specifications.
   c. Data and Voice jacks shall be RJ45 (must be gray).
   d. In addition to complying with the above listed standards, all Category 6 termination hardware shall meet or exceed the following criteria: ANSI/TIA/EIA-568B.2-1,ISO/IEC 11801, IEC 60603-7, FCC Part 68 Subpart F
6. The jack shall be approved to work in all applications up to 100 Mb/sec, including, but not limited to 100 Mb/sec TP-PMD (100 meters over UTP, per ANSI X3T9.5), proposed 155 Mb/sec ATM, 16 Mb/sec token ring, 10 Base T and 4Mb/sec token ring.
7. The modular jacks shall use the color code indicated below:
   a. Data- Blue
   b. Voice- White
   c. Control- Gray
8. The manufacturer of modular jacks is Panduit, mini-com series #CJ688TP or equal.

B. F-Type Module:
1. Module shall be F-Type with a Female to Female connection. Module shall be colored electric ivory.
2. Module shall snap, insert, or otherwise connect to work with specified faceplates.
3. The jacks shall meet or exceed the following standards:
   a. UL Listed
4. Manufacturer of f-type module is Panduit, mini-com series #CMFBA or equal

C. BNC Coaxial Coupler-Type Module:
1. Module shall be 75 OHM BNC coupler with a Female to Female connection. Module shall be colored electric ivory.
2. Module shall snap, insert, or otherwise connect to work with specified faceplates. The jacks shall meet or exceed the following standards:
   a. UL Listed
3. Manufacturer of BNC Coaxial module is Panduit, mini-com series #CMBA75 or equal.

D. F-Type Connector
1. Module shall be a F- Type Male CATV pin connector with braid-crimp cable attachment.
2. Module characteristics:
   a. Impedance- 75 Ohms
   b. Return Loss- 40db @ 1.0GHZ
   c. Insertion Loss- .2db @ 1.0 GHZ
3. Pin type has a standard 5/8-24 UNEF thread. Full cable retention over temperature range of –40F to +140F
4. Manufacturer of F-Type Connector is Amphenol, # 531-F11QP or equal.

E. BNC Type Connector
1. Module shall be a 3 pole male cable receptacle, with nickel housing and silver contacts.
2. Module characteristics:
   a. Contact resistance: < 5 m Ohms
   b. Dielectric strength: 1500 V dc

c. Rated voltage: 250 V ac
d. > 1000 mating cycles lifetime
e. Capacitance between contacts: 4 pF

3. Manufacturer of XLR Cable Connector is Neutrik, part # NC3MD-L-1 or equal.

F. XLR Type Microphone Jack

1. Module shall be a 3 pole male cable receptacle, with nickel housing and silver contacts.
2. Module characteristics:
   a. Contact resistance: < 5 m Ohms
   b. Dielectric strength: 1500 V dc
   c. Rated voltage: 250 V ac
   d. > 1000 mating cycles lifetime
   e. Capacitance between contacts: 4 pF
3. Manufacturer of XLR Cable Connector is Neutrik, part # NC3MD-L-1 or eaual.

G. 3 pole XLR Cable Connector

1. Module shall be a 3 pole male cable connector with nickel housing and silver contacts.
2. Module characteristics:
   a. Contact resistance: < 3 m Ohms
   b. Dielectric strength: 1500 V dc
   c. Rated current: 16A
   d. Capacitance between contacts: 4 pF
3. Manufacturer of XLR Cable Connector is Neutrik, part # NC3MX or equal.

H. RCA Type Connector

1. Module shall include a RCA Connector at one end and a solder connection at the other.
2. Module shall be colored black
3. Module shall snap, insert, or otherwise connect to work with specified faceplates.
4. The jacks shall meet or exceed the following standards:
   a. UL Listed
5. Manufacturer of RCA module is Panduit, Amp, Neutrik or equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not proceed with the work of this section until conditions detrimental to the proper and timely completion of the work have been corrected in an acceptable manner.

B. Notify Architect and Owner of any site problems preventing installation.

3.2 INSTALLATION

A. Verify exact locations of equipment with the architect and owner before installation and other trades necessary to provide a complete and operational system. Immediately notify the Owner and architect of any discrepancies.

B. Coordinate all work and service with the electrical subcontractor.

C. Coordinate final connection of power and ground wiring to equipment with electrical subcontractor. Power and ground wiring shall terminate inside sound rack and provide for interconnection to the building's electrical system.

D. Equipment and enclosures shall be plumb and square. Permanently attach equipment, except portable equipment, firmly in place to the structure. Supports shall be adequate to support their loads at a safety factor of at least three.

E. Prevent and guard against electromagnetic and electrostatic hum.

F. Make connections with accepted connectors and terminal blocks equal to Cinch 140-142 or TRW 142 series. If a device has screw terminal connections in addition to other types of receptacles, terminate cables to screw terminals using accepted spade lug type terminals. Tin all conductors at screw terminals of low level equipment.

G. According to IEC-268 standard, XLR connectors at equipment shall be wired pin 2 hot (high), pin 3 low, pin 1 shield. Drop shields at the outputs and connect at the respective equipment inputs to maintain ground integrity. Connections and signal hookup to low and medium level equipment shall be done in a balanced configuration. Unbalanced wiring without interfaces to balance signal with respect to ground is not allowed.

H. Provide visible termination resistors and not concealed within connector housings or inside devices being terminated.

I. Provide polarity at loudspeaker connections and use the same wire color code for speaker wiring throughout the project. Make joints and connections with rosin-core solder or with mechanical connectors or with terminal strips accepted by the A/E.

J. Pre-wire racks before delivery to project site. Wiring shall be according to standard broadcast practices.

K. Avoid damage to the cables and to the equipment. Isolate cables carrying signals at different levels and separate to restrict channel bleed through and feedback oscillation in any amplifier section. Keep the following wiring separated in groups of conduit:
   1. Microphone level circuits (level below -20dbm).
   2. Line level circuits (up to +30dbm).
   3. Loudspeaker circuits (above +30dbm).
   4. Power circuits.

L. Use insulating “spaghetti” and heat shrink tubing at each connection throughout system with an exposed drain wire or any other exposed shield. Use insulating collars consisting of heat shrink on rack terminations. Positively bond multiple racks together. Bond the racks to the isolated ground buss as applicable.

M. Insulate audio wiring and equipment racks from the building conduit system where applicable.

N. Grounding shall comply with isolated ground conventions described in:
   1. “Establishing A Clean Ground” in Sound and Video Contractor, July, August, and December 1988 issues.
   2. Sound System Engineering by Don and Carolyn Davis, Book Two.
   3. Audio Cyclopedia published by Howard & Sams.
   4. Sound Systems Design by Howard Giddings.

O. Mount XLR connectors to their plates using Phillips oval head screws having a matching finish to the custom panel.

P. Mount equipment to racks using black Phillips screws and black anti-scuff washers.

Q. Engrave provided panels and paint fill.

R. Conceal wiring unless absolutely impossible within the public spaces. Perform installation of wire, conduit, junction boxes, or other fittings in a professional manner consistent with these specifications and Owner's requirements. All labels shall be plumb and square.

S. If any conflicts or omissions occur as a result of the communications subcontractor's unsuccessful coordination of the above-mentioned work, it shall be the communications subcontractor's responsibility to correct and to furnish and install any additional material that may be required at no additional cost to the Owner.

3.3 FIELD QUALITY CONTROL

A. Conduct preliminary checks and testing before performance testing and after completion of related or adjacent work of other trades. Verify safe and proper operation of components, devices or equipment, nominal signal levels within the systems, and the absence of extraneous or degrading signals.

B. Perform the following verification and testing procedures:
1. Provide proper grounding of devices and equipment per manufacturer's recommendation.
2. Integrity of insulation, shield terminations, and connections.
3. Proper provisions of power to devices and equipment.
4. Integrity of soldered connections.
5. Absence of solder splatter, solder bridges, debris of any kind or tools.
6. Proper routing and dressing of wire and cable.
7. "Wire checking" of circuitry, including phase and continuity, concerning cable designations on run sheets, field and shop drawings.
8. Determine the proper sequence of energizing systems to minimize the risk of damage.
9. Measure and record impedance of loudspeaker lines terminating at equipment racks at 1000 Hz, with loudspeakers connected to their respective lines at "full on".
10. Measure and record overall system hum and noise level of each input channel with controls set so that -50dbm microphone input or +4dbm input would drive the system to full amplifier output. Terminate inputs with resistors (150 or 600 ohms) for this test.
11. Measure and record electrical frequency response for each input channel through the power amplifier. Required is flat response with permissible deviation of + 2db within the range of 60Hz to 15Khz.
12. Check polarity of loudspeakers by applying music program or constant power per octave (pink) noise to the system and walking through the transition areas of coverage from one loudspeaker to the next.
    a. Transition shall be smooth with no apparent shift in source from one speaker to the next. This test will be performed by the Owner at final inspection.
    b. Apply sine wave signal sweeping from 60Hz to 5000Hz and at a level of 10db below full output, and listen for rattles or objectionable noises. Correct if apparent.
13. Drive system with broadband, constant power per octave (pink) noise, and measure the SPL at the 4Khz octave band.
    a. Adjust noise level until the meter readings are between 80 and 90db.
    b. Take readings at seated ear height.
    c. Perform listening tests and readjust system for a pleasing overall sound.

d. Use parametric equalizer and “ring out” system to eliminate the major portions of feedback from foldback speakers.
e. Demonstrate to Owner’s operator the adjustment of speakers as necessary to achieve minimum deviation over entire area covered by this system.

14. Check system to assure freedom from oscillations or stray RF pickup.
    a. Check inputs with no signal and 100Hz sine wave signal driving system to full output.
    b. Detect unwanted signals on oscilloscope at rack termination and at loudspeaker connected at farthest distance from rack for each loudspeaker line.
15. After successfully energizing the systems, make preliminary adjustments and document the setting of controls, parameters of corrective networks, voltages at key system interconnection points, and gains and losses, as applicable.
    a. Tabulate data along with an inventory of test equipment, a description of testing conditions, and a list of test personnel as itemized below.
    b. Copies of preliminary test data shall accompany copies of performance testing data as part of the final submittal.
16. Verify the performance parameters of the individual system following established professional procedures, in addition to those specified.
17. Document acceptance testing, calibration, and correction procedures as specified with the following information:
    a. Performance date of the given procedure.
    b. Condition of performance of procedure.
    c. Type of procedure and description.
    d. Parameters measured and their values, including values measured before calibration or correction, if applicable.
    e. Parameters associated with calibration or corrective networks, components, or devices.
    f. The names of personnel conducting the procedure.
    g. The equipment used to conduct the procedure.
    h. Provide permanent labels on controls, as applies, to indicate correct setting after performance testing and adjustment procedures have been successfully completed.
    i. Provide documented voltage settings, hum and noise measurements, final elevations, and angle information for racks and loudspeakers as applicable.
18. Equalize system to provide full range operation and for commission foldback speakers. The final system response shall be set flat from 100Hz to 2kHz, +2dB, and then rolling off 3dB per octave to 10kHz. Average SPL response shall be 80 to 90 dB, “A” weighted and loss of consonants shall be less than 12 percent.
19. Check system to be free from rattles, buzzes, and objectionable distortion. Correct objectionable distortions and retest.
20. Provide operator support at first 2 uses of system after work is completed and accepted per this specification. Support limited to 8 hours of time on site. Provide emergency contact procedures in case of system trouble.

C. Upon completion of the Work and compliance with requirements, the Owner’s representative will verify test data as part of the acceptance procedure. Provide personnel and equipment, at the Owner’s representative convenience, to demonstrate any aspect or parameter of performance and to assist with such tests.

D. Failure of any component or system to meet specifications shall require immediate remedial action. In the event that material, device, equipment, system, or manual skills are found unacceptable as late as 15 days before the substantial completion date, Installer shall provide the temporary installation of operational components or systems satisfactory to the Owner until acceptance of the Work.

3.4 Testing and Acceptance Criteria

A. UTP Cabling

1. At a minimum, provide the results from the following performance tests on all installed UTP data cabling as outlined in ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2 Communications subcontractor will measure and report (in hard paper copies and electronic format) the following link parameters for the permanent link and channel test configurations as defined in TIA/EIA-586-B.1
   a. Wire Map including shield connection if present
   b. Length
   c. NEXT loss, pair-to-pair, measured from local end
   d. NEXT loss, pair-to-pair, measured from far-end
   e. NEXT loss, power sum, measured from local end
   f. NEXT loss, power sum, measured from far-end
   g. EFLEXT, pair-to-pair
   h. ELFEXT, power sum
   i. Return loss, measured from local end
   j. Return loss, measured from far-end
   k. Propagation delay
   l. Delay Skew
2. In addition to these, any performance tests required by the cabling product vendor for issuing and honoring the required 15-year warranty must also be performed.
3. Approved Level II minimum accuracy testing equipment must be used for all tests.
4. Furnish all personnel, labor, meters, instruments, cable, connections, equipment and apparatus necessary for making all tests.

B. Test Plan

1. All test equipment, test procedures, and testing techniques shall be specified in the acceptance test plan and will require approval prior to execution.
2. Tests shall be conducted by the communications subcontractor in accordance with the approved Test Plan.
3. The purpose of this testing is to verify that the installed system meets all specified attenuation and bandwidth requirements and is capable of being used for its intended purpose.
4. Test results shall be submitted for approval. Manufactured or assembled products or equipment shall be tested as indicated, and the results submitted to the District's technical representative for approval, prior to shipment to the site.
5. The communications subcontractor shall prepare a test plan which provides a detailed outline of all testing to be accomplished.
6. The test plan shall include, as a minimum, a schedule of when tests will be performed (relative to installation milestones) , specific test procedure that will be used, a list of test equipment that will be used (manufacturer, model number, range, resolution accuracy) and shall conform to the specified requirements of other sections of this specification.

C. Test Results

1. Each test sheet shall have a sign-off blank for the communications subcontractor, as well as the District's technical representative. Copies of the completed test forms or test results shall be delivered according to the shop drawing procedures.
2. The communications subcontractor shall maintain an accurate test record during all field tests. Samples will be provided to the awarded vendor. Any communications subcontractor developed format for recording test data shall be submitted for approval as part of the test plan.

3.5 CLOSEOUT

A. Perform remedial work to correct inadequate or unacceptable conditions of, or relating to any portion of the Work, as determined by the Architect or Owner, at no expense to Owner.

B. Furnish equipment to the Board along with complete manuals and connection drawings of the materials presented. Equipment shall be in the original manufacturer's packaging, complete with included instructions and miscellaneous manual and documents.

C. Present, review, and clarify materials to the Owner, Owner's representative and operating personnel and fully demonstrate the operation and maintenance of the systems, equipment, and devices as specified.

D. Check, inspect, and if necessary adjust systems, equipment, devices, and components specified, at the Owner's convenience, approximately 60 days after the Owner Acceptance of this work.

E. Further adjustments or if additional work becomes evident during acceptance of the system, the communications subcontractor will continue his Work until system is acceptable at no additional cost to the Owner. If approval is delayed because of defective equipment, failure of equipment, or installation to meet the requirements of these specifications, the communications subcontractor shall pay Owner expenses for additional time during any extension of the testing and acceptance period.

3.6 DEMONSTRATION

A. Provide on-site training to the facility's personnel (faculty and staff) on how to set-up, operate, and test systems for proper function in accordance with paragraph 1.11.

END OF SECTION

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Section 27 50 00

DISTRIBUTED COMMUNICATIONS AND MONITORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of a Contract, including conditions of the Contract and Division 1 of the Specifications, shall apply to the Work in this Section.

B. Drawings and general provisions of the Contract, including all portions of the Project Manual are hereby made a part of this Section. Refer to paragraph titled “Quality Assurance” in this section and to Division 1 for requirements for Communications Subcontractors. Throughout this and related Sections, “Subcontractor” shall not be limited to the singular and masculine and shall refer to one, or more than one, Communications Subcontractor. The Terms “Communications Subcontractor” and “Communications System Integrator “ shall be used interchangeably and shall be understood to represent the communications subcontractor responsible for the furnishing, configuring, testing, programming, warranting and ensuring all work is performed in accordance with manufacturer’s requirements and recommendations for the work identified in this SECTION.

C. Any qualifications or certificates required in this specification may be requested by the Architect as part of the post-bid qualifications review. Such review shall commence subsequent to the bid submission, as none of this information is required as part of the bid submission. In the event that the Architect requests qualification or certification documentation such documentation shall be provided within 3 business days.

1.2 SUMMARY

A. Work Included. Any and all cabling mentioned herein and required to complete the work of this section shall be coordinated with the communication subcontractor of this section, and provided and installed by the Structured Cabling communication subcontractor of section 27 10 00 so long as it does not void any manufacturer warranty. The communication subcontractor of this section is responsible for any cabling required by the manufacturer to ensure manufacturer’s warranty. The scope of work of this Section consists of the designing, installation, and programming of all materials to be furnished under this SECTION, and without limiting the generality thereof, consists of providing all labor, materials, equipment, plant, transportation, appurtenances and services necessary and/or incidental to properly complete all work as shown on the drawings, as described in the specifications, or as reasonable inferred from either or, in the opinion of the Architect and Owner, as being required and in general, is as follows:

1. Public Address System, including but not limited to:

a. Public address system amplifiers, zone controls, back boxes, and all equipment, cabling and support required to interface the Public Address System to the Owner’s Telephone System (Phone System Not included in this contract - coordinate with Owner).

b. Public Address System Speakers, ceiling and horn flush and surface mounted, wall flush horn mounted, both interior and exterior.

c. Cabling to support the Public Address System (NOTE: any category 5/6 cable must be Gray).

d. Equipment rack or cabinet

e. Volume attenuators (A symbol in a circle) where shown on the drawings to adjust the PA speaker sound level.

f. Call boxes/switches where shown on the drawings (CB symbol). All call switches shall be provided with a safety cover. Provide and install an STI-13010CW at all call button locations, labeled “CALL BUTTON”.

g. GPS Master and Secondary Clock System, clocks and cabling.

h. Provide PA override signal to local sound systems (Gym, Student Dining, Press Box, Small Group Seminar, Auditorium, storage/support/restroom facility and PE Alternative Room. Coordinate with 27 40 00 communication subcontractor.)

i. PA integration with Access Control system. Coordinate event (coordinate event with Owner) in PA system to be triggered by access control contact closure (panic button). Integrate cabling provided by Access Control into PA system. Coordinate with 28 13 00.

j. Provide PA administrative stations (one at each A3 and A4 location, including storage/support/restroom facility). Coordinate cable required and jacks for termination with 27 10 00. Provide and terminate jacks in faceplate.

k. PA System shall be independent from the phone system and shall not rely upon a phone system to function; however the PA system shall be integrated with the phone system to allow the phone system to initiate pages to zones.

l. Program paging zones in accordance with owner direction. Coordinate with owner. At a minimum, each interior floor, and the exterior shall each be an independent zone.

m. All sound systems, including classrooms, (in addition to above systems) require an input from the PA system to mute the audio of the sound system. Provide input in coordination with 27 40 00 communications subcontractor for sound systems (contact closure, voice signal, or similar)

n. Where noted on the drawings, provide a dedicated amplifier in the local IDF to provide 7.5w minimum to each PA speaker (HS and FS symbols) in the space. See Gym, Auditorium, Student Dining, Automotive, and Construction Shop . Provide an amplifier for each location. None of the HS or FS speakers shall be used for talk back.

o. Provide black speaker grill (or paint grill black) and black back box (or paint box black) for ceilings of room 123. Call box shall be black or steel if black is not available in room 123. Provide black grills and black boxes in lower auditorium space as well.

p. Technology drawings symbols to be provided under this section, as shown on T2.0 and T2.1 are: SP, ES, FS, HS, A (attenuator, unless noted otherwise- see practice rooms behind auditorium), C, C12, C16, CB (call box), A3 and A4 locations for PA Admin Phone, and any other symbol reasonably determined to be part of the PA system.

q. All equipment described in this Section shall be provided, configured, tested, programmed and warranted by a manufacturer certified communications subcontractor. Communications subcontractor shall provide proof of manufacturer certification.

r. Provide every required part of system complete in detail and operable in unison with all other sections of this specification, resulting in a complete Distributed Communications system.

B. Actual control room and rack layouts will be based upon the specific designs submitted by the communication subcontractors. Needs for equipment, specific speakers, and other equipment will be dependent on actual product manufacturers. Communication

subcontractors shall coordinate room layout, actual speaker and equipment placement and programming options with owner prior to installation.

1.3 RELATED SECTIONS

A. Field Painting: DIVISION “FINISHES”
B. SECTION 01 23 00 - ALTERNATES
C. Electrical: DIVISION 26 00 00
D. All Communication Sections, 27 and 28.
E. SECTION 05 31 00 – STEEL DECKING See for restrictions concerning the hanging of material, cable tray, mounts, brackets, hooks, and other items from the roof or decking

1.4 SECTION INCLUDES

A. Central processor assembly

B. Administrative consoles (at A3 and A4 locations on the drawings. Coordinate connector in A3 and A4 faceplate and cable to MDF or as per system requirements for remote locations with 27 10 00 communications subcontractor)

C. 4” digital clocks (C symbol) 12” analog where noted on the drawings (C12) and 16” analog clocks as noted on the drawings (C16).

D. Digital Readout units

E. Bell/Class change signaling system.

F. Public Address/intercom System

G. Controls, Amplifiers, and Terminal Equipment

H. Power Supplies

I. Battery Backup for System Programming

J. Program Distribution System.

K. Master Clock System

L. Telephone controlled intercom system

M. Web interface for Bell schedule

N. Programmable, individual control of inputs and outputs

O. Ceiling/Wall Mounted loudspeaker assemblies

P. Surface and flush clocks and clock and loudspeaker baffles

Q. Accessories

R. Wiring

S. Interior and Exterior Enclosed Horn Type PA Speakers

T. Speaker volume attenuators where shown on the drawings.

U. Call switches and covers where noted on drawings (CB symbol, must provide cover with all call buttons)

V. PA system shall not rely on a phone system to fully function.

W. Dedicated amplifiers for PA speakers in student dining, auditorium, automotive, construction shop and gym.

1.5 SUBMITTALS

A. Architect may require submittal submission within 45 days of bid award. Submit the following under provisions of Section 01 33 00- SUBMITTAL PROCEDURES:

B. Product Literature: Manufacturer's product data sheets, specifications, performance data, physical properties and installation instructions for each item furnished hereunder. Ensure submittal is tabulated with index referencing the specification sections. Non tabulated and indexed submittal shall be returned without action.

C. Alternate systems being submitted for this bid shall provide a tabulation specification clearly comparing the submitted item with the specified item, being able to refer to all written expressed functions and capabilities. Specification sheets shall be submitted on all items including cable types.

D. Shop drawings, detailing the communications network system including, but not limited to, the following:

1. Device locations and wiring (PA speakers, call boxes, administrative consoles, attenuators, clocks, etc)

2. Interconnections (access control inputs, sound system mute outputs, etc)

E. Provide a riser diagram for the system showing in technically accurate detail all connections, interconnections, and all provisions available and made for adaptability of all specified future functions and including all calculations, charts, and test data necessary to demonstrate that all systems and system components deliver the specified signals, grades, and levels at all required points and locations.

F. Manufacturer Certificate and Certified Training Certificates of communications contractors who will be providing, programming and warranting the equipment.

G. Closeout Submittals:

1. As-Built Drawings: Update Shop Drawings to create final As-Built Drawings. Submit 3 copies digitally in AutoCAD 2010 or later format on a CD.

2. Operation Data: Include three (3) copies of the software Administrator and Operator Manuals.

3. Maintenance Data: Include three (3) copies: maintenance and repair procedures.

4. Digital copies of all training materials and DVD videos of all training provided on CD and

DVDs.

5. Estimated costs for maintenance and software assurance for the system on a yearly basis.

6. Submit costs for repairs and service not covered under warranty (ie: owner requested changes, acts of God, vandalism, misuse, etc).

7. Warranty certificate with contact numbers with appropriate start and stop dates

8. PDF of product data and O&M manuals shall contain bookmarks for every section and item submitted.

1.6 DELIVERY, STORAGE AND HANDLING:

A. Deliver products in factory containers. Store in clean, dry space in original containers. Protect products from fumes and construction traffic. Handle carefully to avoid damage.

1.7 QUALITY ASSURANCE

A. Manufacturers: Manufacturer shall be a single-source manufacturer for the system, that specializes in PA systems with a minimum of 5 years in the industry.
B. Communication subcontractor: Company specializing in Distributed Communications and Monitoring Systems, with a minimum of three years experience on systems of similar size and scope. Communications subcontractors working on project must have been certified by the manufacturers on the hardware and software used for this project. Provide valid current proof of manufacturer's certification.

1.8 REGULATORY REQUIREMENTS

A. The entire installation shall comply with all applicable and safety codes. All central equipment and additional applicable equipment shall be Listed by Underwriters' Laboratories, per US requirements Note: Furnish an original, dated specimen of the test agency's listing card with the submittal.

B. All equipment with digital apparatus (microprocessors) that generate and use timing signals at a rate in excess of 9,000 pulses per second to compute and operate must be Federal Communications Commission (FCC) and DOC CSA standards C108.8 (Electromagnetic Emissions) compliant. Any non-compliant equipment supplied or installed shall not be accepted and shall nullify the contract. Note: Provide documents supporting and verifying compliance.

C. Systems shall be considered non-compliant unless they completely meet the criteria as outlined in this section. All supporting documentation shall be included as part of the initial submittal package. Letters regarding "future approval" or "approval pending" shall not be considered.

1.9 WARRANTY AND SERVICE AGREEMENT

A. All equipment, materials, and labor shall be guaranteed for a period of 36 months from the date of final acceptance by the Owner. Warranty shall begin at this time, not the date of substantial completion. Systems must be fully operational, and accepted by the owner after training before the warranty is to begin.

B. The manufacturer or communications subcontractor shall repair or replace malfunctioning products at no expense to the Owner, except failures caused by damage or unreasonable

use.

C. Communications subcontractor shall maintain regular service facilities and a help desk. Provide qualified technicians that are experts in Telecor Systems, and who are familiar with the work at the site, within 24 hours of receipt of a notice of malfunction, excluding weekends and holidays.

1. Provide material, devices, equipment, and personnel necessary for repairs.

D. Provide accepted temporary, alternate equipment, if required by the Owner, complete and operational within 48 hours after notification of malfunction, at no additional cost during the first year of warranty.

E. Communications subcontractor shall conduct warranty repairs and service at the project site unless prohibited by manufacturer's warranty. If the latter, communications subcontractor shall provide substitute systems, equipment, and devices acceptable to the Owner for the duration of the off-site repairs. Replace items out of service more than 10 days with new equipment during the warranty period.

F. Communications subcontractor shall transport warranty equipment, substitute systems, test systems, equipment, devices, materials, parts, and personnel to and from the project site at no additional cost to the Owner.

G. Provide any software maintenance updates or upgrades to all systems at no additional cost to the Owner for this 36 month period.

H. Response Times - Normal business hours shall be 7 AM to 5 PM Monday through Friday. Calls for service before noon shall be responded to on-site before the end of the day. Calls after noon shall be responded to on-site by noon the following business day.

I. Provide extra costs for time outside of normal business hours if the Owner requires emergency service.

J. Submit an all-inclusive Annual Maintenance Agreement and software assurance agreement cost for years 4 and 5, in the close out submittals.

K. Submit normal and after hours labor costs and typical costs for equipment for items not covered under the Warranty, like: Acts of God, vandalism, misuse.

L. Service Calls: Provide 24 hours of service calls on system for the school after final acceptance to make any adjustments necessary to keep system at peak operating condition. Warranty work is not included in the service call time.

1.10 MANUFACTURERS

A. Telecor Inc
B. Rauland
C. Bogen

1.11 ALTERNATES

A. Alternate 2 – Storage/Support/Restroom Facility. All related work on T2.4 for the facility shall not be included in the base bid. This work shall be included in the ALTERNATE 2 bid. This work includes associated equipment to extend the PA system to the building, back boxes and speakers, clocks, enclosures, PA admin console at A4, and PA override signals for the local sound system in the facility.

PART 2- PRODUCTS

2.1 PUBLIC ADDRESS SYSTEM

A. Specified Manufacturer: To establish a standard of quality, design and function desired, Drawings and specifications have been based on the T2 equipment by Telecor Inc

B. The Public Address System shall consist of the Central Control Unit, Administrative Consoles, PC-Based Graphic User-Interface (GUI) web-based editor, rack equipment and all other necessary devices that are required to create a complete and operational system such as Speakers, Horns, Amplifiers, and Visual Message Devices. All Public Address main equipment including card cages and all cards, power amplifiers, program sources, and other equipment, shall be rack mounted in the MDF room. Most system programming of Public Address and Master Clock features shall be accomplished remotely, by an Administrative Console and GUI located in the Main Office area or over the LAN/WAN. It shall not be necessary to attend to the main equipment in the Head End for normal day-to-day operation of the system. The system shall be a 25-Volt two-way paging system providing paging zones as indicated and determined by the Owner. The system shall be of modular design utilizing plug-in circuit cards to enable quick on-site replacement or addition of components for system expansion and modification. The system head end equipment shall be rack-mounted in the MDF where shown on the drawings with side panels and stationary platform base. Provide shelves, doors, blank panels, AC power distribution, and other equipment or materials to support all equipment and fill empty rack space. System shall be comprised of all solid-state electronics, utilizing a microprocessor-based central processor unit, power supplies, audio interface cards, control cards, input/output cards, telephone interface cards, transformers, paging amplifiers, and other equipment and materials for a complete system, to include equipment and installation to interface with the Owner's VoIP telephone system. The interface must comply with loop-start central office (CO) trunk standards in North America as defined by Bellcore and/or industry-standard 2500 analog station ports.

C. The system must include a GUI application that allows for the operation of the System from a Windows®-based PC on the network. Provide networked PC, (coordinate location with Owner), keyboard, mouse, and 21" LCD Monitor if required. PC shall exceed manufacturer recommended specifications. This software package shall utilize an easy-to-use graphical user interface (GUI), quick graphical access to paging, and program distribution. The software shall also allow easy activation of class change schedules. Emergency operations shall be simplified through this software application by allowing stored audio files and alphanumeric messages for message displays to be activated from the GUI. The GUI shall allow common operations such as daily announcements to become automated with the use of the GUI, removing multi-step console set ups. While all operations are conducted from the PC screen, the Administrative Console or Telephone handset shall provide the means for originating voice communications to selected locations. The Software GUI shall provide:

1. Simple Routine Call Processing
2. Emergency Functions
3. Paging
4. Audio Program Distribution
5. Enabling and Disabling of Schedules and Bell Scheduling

D. The GUI shall provide an efficient and reliable method of notifying the occupants of a facility of critical situations. A variety of emergency tone signals that reside within the Intercom/Paging System shall be activated by clicking on pre-programmed buttons on the PC GUI screen, initiating the transmission of tone signals to speakers. A 'lockdown' audio message as per Owner direction,

with owner selecting the appropriate tone, shall present on the system by a contact closure from the access control system. Provide/install cabling to access control system and coordinate integration with access control 28 00 00.

E. The main system shall include a Telecor T2/XL head-end, a networked PC with Microsoft Windows XP or Vista running Telecor's Visual Console software (if required for the Telecor GUI), a monitor, data entry keyboard, control console, serial connections to in-house alert systems, UPS power backup (provide one UPS for headend unit and one for visual console PC if provided), interfaces for network access (an IBP-1, IP Broadcast Interface card with site license; and a CNI-1-XL/T2 Notification Interface device), a Category 6 plenum rated structured cabling system with C5PPL Patch Panels in IDF's, and all associated system components to provide:

1. Direct dialing, two-way "amplified voice" communications between all locations equipped with Control Console, and/or telephone system handset, and all locations equipped with a public address system speaker; excluding corridor speakers.

2. An Administrative Control Console (located at all A3 and A4 symbols) for facilitating all Public Address System announcements and programming, to include but not be limited to: Emergency all-call; paging zone and number assignments; call-in priority levels with tone characteristics; Master Clock event and tone signaling; monitor and reporting on call-in line faults; and manually distribute unique tones to all zones and speakers in the system. Emergency paging from any call button shall display on all admin consoles

3. A rack mounted Tel-Comm Server provides network connectivity from authorized PC's to remotely control or program the T2/XL systems. Tel-Comm Server provides remote system diagnostics and access to activity log files on the T2/XL system. It also provides support for the Visual Consol program and integrates the functionality of an MCC-300 Administrative Consoles into the framework of a PC. Audio files that are used for daily as well as emergency announcements and music files can be stored in the Tel-Comm Server for retrieval. The server also provides for the synchronization of the T2/XL to a master time keeping source. This can be a time source within the facility or an external time server via the Internet.

4. Connection to a local building digital PBX or VoIP telephone system (phone system by Owner), allowing any telephone handset that is part of the telephone system to page and conduct hands-free, open-voice communication with any speaker in the system; the Control Console; or any other classroom telephone. The Connection to the local phone system shall not diminish or restrict any of the capabilities of local telephone system. Public Address System interfaces shall allow any programmed telephone to perform but not be limited to the following intercommunication system functions: all-call; zone call; intercom call to classroom speakers, and distribute class change signals.

5. User-programmable zone paging to all classroom and office speakers using microphone, Control Console, or telephone. Public address zones shall be software programmable to include 1- and 2-digit numbers. Zone paging shall be independent of time and program zones and shall provide easy access to groups of zones or all-zone pages.

6. Distribution of general announcements over School loudspeakers using a microphone, Control Console, or telephone handset, on an All-Call basis, pre-selected zone basis, or multiple-zone basis to any paging zone. Speaker assignments to any zones shall be programmable from the Web Editor.

7. Distribution of emergency paging announcements over school loudspeakers using a microphone, Control Console, GUI or telephone handset. Emergency announcements shall have the highest priority over all other system functions, including the Local Audio Systems. Emergency announcements shall automatically disconnect and override all Local Audio

Systems. Provide programming source to override local audio systems in Auditorium, Cafe, PE Center, Small Group Seminar, Storage/Support/Facility and Gym. Coordinate with 27 40 00 communication subcontractor.

8. Selection and monitoring of individual program sources (Microphone, AM/FM Tuner, Tape or CD) and distribution by the Admin Console.

10. Control Console programming of administrative microphone for control and distribution of public announcements, to eliminate the need to go to the central electronics for microphone set up. Keying the microphone shall automatically mute all other audio programs at a lower priority in the system, including Local Audio Systems (emergency pages only). Microphone shall transmit to all rooms or specific speaker zones as programmed in the system software.

11. The capability of multiple open-voice intercom paths. Intercom paths shall be global.

12. Automatic gain-control of intercom speech to assure constant speech level.

13. Automatic sounding of a warning tone over any loudspeaker selected for two-way communications to alert the classroom teacher to an incoming announcement.

14. A minimum of two channels for intercom communications or audio program distribution. The System shall be user-programmable to allocate, upon demand, either of the two channels for intercom or audio program.

15. The ability to monitor the school building either on or off the premises from a single telephone.

16. Audio program distribution to eight different areas of the building selected by the Control Console. Inputs shall be provided for five (5) low-impedance microphones, tuner, tape player and auxiliary source. Program material shall include audio programs from standard AM/FM tuner, tape deck, CD player, or auxiliary source. Control Console shall have the ability to monitor program sources being distributed. Coordinate location of antenna(e) with architect. Locate and install for optimal performance.

17. Audio Source equipment shall have the ability to be located remotely from the main system control electronics, and shall have the ability to distribute two channels of audio simultaneously if so desired. School shall be equipped with (1) rack-mounted AM/FM tuner (with iPod dock capability), (1) rack-mounted CD player. Ipod must be able to interface with sound system to provide sound over PA system to all or selected zones.

18. RS232 Input/Output Interface, Personal Computer, LAN/WAN, Modem, and Printer for monitoring activity within System and for displaying and printing system management information. System shall perform diagnostics, or logging transactions either on or off premises.

19. The ability to interface to the power supplies of door strikes and to allow remote control of door strike through the paging system.

20. Time Signal tones of an integrated Master Clock System to be distributed throughout zone(s) selected for time signaling over programmed loudspeakers on a manual or automatic basis.

21. A Global Positioning Satellite Receiver (GPS) shall be provided and installed. By receiving accurate time signals from 24 satellites in orbit around the earh, the 2400-SR Receiver provides for an alternative time base for Telecor's 2400 Series of Master Clocks and the 2490

Transceiver used with Telecor Wireless Clocks. Conduit from the MDF to the roof is available for installation of GPS antennae. Seal all penetrations.

22. Power amplifiers that provide a minimum power capacity of 2 watts per cone speaker location, 7.5 watts per interior horn speaker, and 15 watts of power per exterior horn type speaker location.

23. Cabling that is specified by the manufacturer, which provides shielding of conductors so that the Public Address System does not interfere with the Telephone Systems and Telephone System cabling.

24. The system must be compatible with a structured cable plant with MDF and IDF and CAT6A cabling.

25. Classroom components (including a speaker and clock) may all be connected to the system via a single CAT6 cable drop for each classroom/location to either the MDF or IDF in a Networked solution.

26. Pre-announce tones will alert the listeners of incoming calls with distinct tones for each priority level. To prevent unauthorized monitoring, the tone will sound whenever an area is being monitored, and will repeat at regular intervals. Facilities shall also be provided to defeat the tone repeat function from the administrative console if it is not desired.

27. Emergency and All Call paging and a minimum of 16 zones of group paging. The paging zones shall be independent of the time tone and audio program distribution zones. Systems sharing zones for both paging and tone shall not be acceptable.

F. The system shall be capable of monitoring 16 different sections of the building, either on the premises from a control console, or off premises from a telephone instrument.

G. Distribution of paging announcements can be made from any administrative control console, GUI, telephone, or dedicated microphone set-up.

H. Emergency announcements shall have the highest priority over any other system function and seize all system loudspeakers regardless of their current mode of operation.

I. System shall support general announcements made from a conventional microphone to facilitate reading a script and the participation of multiple announcers. Keying the microphone shall automatically mute all other audio programs at a lower priority in the system and transmit the microphone audio to all buildings or specific speaker zones, as programmed into the system software.

J. System will provide Emergency and All Call Paging and a minimum of 16 zones of group paging. The paging zones shall be independent of the tone signal and audio program distribution zones.

K. Pre-announce tones will alert zones of incoming pages with distinct tones for each priority level.

L. The system must have the capability of distributing audio program sources from any administrative telephone or authorized building telephone. Program distribution shall be accomplished on an all zone, selected zone, or individual zone basis.

M. The system shall support the automatic distribution of tone and text signals to all selected areas.

N. The system shall support a minimum of 1536 events and 16 schedules. Building zones shall be used to select which areas receive the tone. They must be totally independent from page zones and program zones.

O. All signal programming shall be accomplished from a PC utilizing a standard web browser. The system shall support running all time schedules concurrently.

P. The duration of the tone, as well as frequency, burst length and output level shall be software programmable from a web browser.

Q. All system tones shall be user-programmable for the following durations in seconds: 2, 3.5, 5,6,8,10,12.

R. The system shall be capable of an open-voice intercom path used for monitoring, emergency paging, and intercom.

S. The system shall have an IP-based Broadcast Interface capable of receiving pre-recorded or live messages from the district office (hardware at district office not in contract).

T. Corridor speakers, and outside horns in each building shall be combined into groups of owner's preference. There must be 16 independent software paging zones that each circuit may be a part of. Each individual circuit must also have the ability to be paged independent of the software zones.

U. Station wiring shall be connected to the system using insulation displacement connectors to allow quick disconnection of field cables from the System terminal boards.

V. All user-programmable data shall be stored in a non-volatile EEPROM memory to prevent memory loss during a power failure. The system time clock shall be capable of maintaining correct time for a period of 14 days in the event of a power failure. It shall be possible to return the system programming to the original factory default setting by keying a special code from the Console.

W. The user shall have the capability to change system programming for all paging functions, bell functions, and clock functions. The Owner shall be provided with the required training, documentation, and software to accomplish these functions.

X. The system shall be connected to a (owner-provided) Ethernet network port using the TCP/IP protocol. Provide patch cord of sufficient length to connect the head end equipment to the owner provided network switch in the MDF.

Y. The user-interface shall support user names and passwords. There shall be multiple levels of access allowed. Some users may have view privileges only while others may edit their site. All editing shall be by means of the Web Editor.

Z. The program shall also serve as part of the documentation process. Page Zones and bell schedules shall support user-definable names and display as pick lists when editing the configuration.

AA. Diagnostic functions shall be accomplished through any PC connected to the school network and provided with the proper authorization and diagnostic software. Any off-site PC shall have access to the system for diagnostics through the use of the public internet, provided that they have been granted proper authorization and have been provided diagnostic software.

BB. Although the system is programmed through a PC interface, the system shall not have to rely upon a personal computer for day-to-day operation. All programming information shall be loaded into the XL system allowing independent operation of the system.

CC. Provide a -1dB balanced audio line-level output from the public address system to each local sound system (listed in this specification, ie: gym, auditorium, small group seminar, student dining, PE Alternative and storage/support facility) and provide equipment, cabling and signals for emergency pages to over-ride the local sound systems. Coordinate with the owner prior to installation during paging zone identification.

DD. The final copy of the program and the configuration of data files shall be provided to the school in electronic format.

EE. Provide Microphone for general announcements; unit shall be a hand-held microphone device with a table stand. Microphone shall be Shure 522 or equal. Communications subcontractor shall use XLR type connectors and West Penn 2529 cable or approved equal between the front office location and the Public Address microphone interfaces. Locate microphone and cabling at one of the A3 faceplates in the admin area, coordinate location with Owner. Use open ports for VES cabling in A3 faceplate and terminate XLR connector to cable, not faceplate.

FF. Wire (via cabling to access control panel) panic button switches (PB symbol on drawings, provided by 28 00 00 communication subcontractor) to PA system for contact closure input. Upon contact closure, PA system shall initiate a lockdown sequence, as specified by owner. Coordinate lockdown events with owner (tone, message on all digital clocks, and so forth) and provide programming to accomplish lockdown procedure.

GG. Unspecified Equipment and Material. Any item of equipment or material not specifically addressed on the Drawings or in this Document and required to provide a complete and functional installation shall be provided in a level of quality consistent with other specified items.

HH. The system shall allow a telephone and a call box to be associated directly with a loudspeaker by assigning them the same dial number.

II. Provide a call switch in every class room and where shown on the drawings (designated CB on drawings).

a. Call switches shall be provided and shall be programmable and capable of routing incoming calls from classrooms to a specific control console or specific group of consoles. Every point shall be individually programmed. Up to 16 different console groups can be assigned.
b. The system shall support both "normal calls" and "emergency calls" from a single call switch. Merely depressing the call switch repetitively 3 times shall initiate emergency calls. Call switches may also be programmed to initial an emergency call by pressing and holding the button for three seconds.
c. All call switches shall be associated with a speaker assembly.
d. Every call switch point shall support an independent programmable priority level
e. The Call-In Switch shall be tamper-proof in design and construction.
f. The face plate shall be fabricated from 11 gauge stainless steel with a brushed, mar resistant finish.
g. The switch actuator shall be fabricated from solid metal, and connected to the faceplate by a pair of welded studs. It shall be no less than 1/2" in diameter and shall be situated flush to the front of the face plate. The actuator shall activate a momentary contact switch whose movement shall be limited by a mechanical stop to prevent damage caused by heavy impact.
h. The call switch shall mount on a standard single gang electrical box, no less than 2- ½ " deep.
i. Tamper-proof hardware shall be provided.

j. Provide pull cord call switches in bathrooms with CB symbol. Cord shall be a maximum of 6" from floor
k. All admin consoles shall be notified of any call button emergency call.
l. Provide and install a cover over every call button/switch. STI-13010CW by Universal Stopper, without horn. Each cover shall have the label applied, to read "CALL BUTTON".

JJ. LOUDSPEAKERS, BAFFLES, AND BACKBOXES

1. Speaker/Baffles: Provide backboxes to electrical subcontractor for installation.
   a. As indicated on plans (SP), provide a ceiling mounted round speaker and baffle assembly. The baffle shall be 12-7/8" in diameter and 3/8" deep. The circular design shall match the room ceiling tiles.
   b. Baffle shall be constructed of 22 gauge, cold rolled steel, coated with a baked on white powered epoxy that is resistant to scratches.
   c. Holes in the baffle shall allowing mounting to speaker backbox.
   d. Room speakers must allow hands free talk back when room is paged.
   e. Speakers must meet the following:
      1. Type: Flush mounted 8" cone
      2. Frequency Response: 50 to 18,000 Cycles
      3. Magnet: 6 oz.
      4. Axial Sensitivity 95 dB at 4 ft. with 1-watt input
      5. Telecor STB-11 Speaker/Transformer/Baffle Assembly with T8 Support Bridge and H8 Enclosure or equal.
2. Provide Volume attenuators where shown on the drawings (A symbol in a circle) to adjust the volume of the local PA speaker.
3. Horn Speakers: Indoor/Outdoor: External Building PA Speakers (as shown on technology drawings ES (recessed, enclosed), press box PA speakers (surface mounted on press box, shown as ES), and internal PA Speakers for the Gymnasium, Auditorium, Shop and Automotive and Student Dining (as shown on technology drawings FS and HS, recessed/flush mounted (FS) and HS surface mounted with back boxes).

   ES type:
   a. Double re-entrant type: flush mount installation.
   b. Frequency Response: 600 to 14,000 Hz.
   c. Power Handling: 15 Watts RMS, 30 Watts Peak.
   d. Variable screw taps, 25 V transformer
   e. Sound Pressure Level: 110 dB at 1 meter with 1-watt input
   f. Color: Coordinate with Architect.
   g. Atlas/Soundolier APF-15T Horn Speaker with 193-8-6 backbox (9-5/8" Sq X 6" Deep) and VP-161APF Speaker Baffle or equal.

   FS and HS type:
   a. Aluminum re-entrant type: flush mount installation, surface mount box.
   b. Frequency Response: 600 to 12kHz nominal.
   c. Power Handling: 15 Watts RMS.
   d. Variable screw taps, 70/25 V transformer (25:.48/.94/1.8/7.5/15w; 70:.9/1.8/3.8/7.5/15W)
   e. Sound Pressure Level: 105 dB at 1 meter with 1-watt input
   f. Color: black in lower auditorium/stage.
   g. Lowell Unihorn LUH-15TI Horn Speaker with LUH-TBAR tile bridge were required (upper auditorium, student dining), and LUH-BOX where required (gym, shop, automotive, lower auditorium).

h. Dispersion 80degrees

KK.TELEPHONE INTERFACE

1. Communication subcontractor must provide system interface and connection to the Owner's telephone system (Provided by owner). Provide all equipment and cabling necessary to connect and integrate system to the phone system.
2. Each trunk shall be programmable as either incoming, or outgoing, or both.
3. For incoming trunks, system shall be able to direct calls to a user-defined attendant telephone or provide dial tone. For outgoing trunks, system shall provide access to the trunk by dialing 8, 9, or both. If digit 9 is used to access an outgoing trunk, the system shall be able to automatically dial a second 9.
4. Each trunk shall be loop start.
5. Communication subcontractor of this section must coordinate telephone interface with Owner.
6. The PA system shall be fully independent from the phone system but provide integration to the phone system as mentioned above.

LL. INTERFACE WITH REMOTE SOUND SYSTEMS

1. The system will interface with remote audio systems in the following locations to mute source material upon pa announcement:
   a. Student Dining
   b. Gymnasium
   c. Auditorium Control Room
   d. PE Alternative
   e. Small Group Seminar
   f. Storage/Support/Restroom Facility
   g. Classroom auxiliary sound and voice lift systems
   h. Press Box

2.2 MASTER CLOCK AND SECONDARY CLOCK SYSTEM

A. The system shall provide "State of the Art" Technology for Master Clock and Secondary Clocks, so that they form an integrated system together and with the Public Address System. Time programming shall be accomplished by way of a microprocessor-based and user-programmable master control system. The system shall be easy to learn and operate. All standard system programming shall be user-friendly to allow the system administrator the ability to easily reprogram system features. Features offered by this system shall be implemented and controlled by software programs that can be changed and expanded as customer needs evolve. The Master Clock shall use an integrated master controller capable of operating and correcting both digital and analog secondary clocks as well as controlling class change signals to all speakers. The Master Clock systems shall provide the required signals to assure synchronization of all Secondary Clocks. Provide equipment and integration as necessary to utilize the master clock system as a network time source for the school LAN. The Master Clock System shall be by Telecor, Inc., Bogen, Sapling or equal. The master clock shall include a web interface.

B. Master Clock System shall provide the ability to:

1. Provide automatic distribution of user-programmable time signals controlled from an integrated, 24-schedule, 1,024-event time clock. Time signal programming for 16 of the 24 schedules shall be available from the Web Editor. Eight (8) of the 24 shall be available at the Control Console.

2. Provide for program override to support manual distribution of class change time signals to all areas, or select groups of speakers from the control console.

3. Transmit class change tones to selected areas of the school. Duration of the tone, as well as frequency and burst length and output level shall be software-programmable from the

Control Console with 500 different combinations possible. User-programmable time signals shall be available to any of 16 time zones independent from paging and program zones.

4. Incorporate a built-in calendar with the capability to program in all holidays, and provide for automatic clock correction for Daylight Saving Time and Leap Year changes.

5. The unit will further permit programming, diagnostic, and activity logging through connection to an external computer.

6. Provide a 10-year battery back-up real time clock.

7. Battery back-up shall be provided to the Public Address/Intercom/Clock System, ensuring correct timekeeping of the Master Clock System during power failures. Once power is restored, the Master Clock shall instantaneously update all clocks with the correct time.

8. The Master Clock shall be capable of correcting analog secondary Clocks without the need for special hardware.

9. The ability to connect through the facilities Ethernet Network to obtain time synchronization from a Time Server.

10. The system shall have the capability of providing alpha-messaging as part of the time/tone schedules. The integrated Master Clock shall provide sixteen (16) user-programmable messages which may be activated as a part of the time/tone schedules, external relay, remotely located buttons, or through the front panel of the unit.

C. The Digital Clock (provide at C symbols in a circle as shown on the drawings), shall be designed for use in conjunction with the Telecor II/XL Communication System (or equal by the manufacturer submitted). Telecor model 2484.

1. The Digital Clock shall display the current time. The time shall be displayed in hours and minutes. Hours and minutes shall be displayed using 4.0” digits.

2. All secondary clocks shall be continuously synchronized with the Master; corrections shall be done instantaneously and all clocks shall display the identical time. In the event of a power failure, the Telecor system shall maintain proper timekeeping during the outage. Once power is restored, all clocks shall be immediately updated with the correct time.

3. The Digital Clocks shall utilize AlGaAs “Super-Bright” LED displays which shall offer exceptional visibility characteristics and shall be viewable from up to 120 feet away.

4. The clock bezel shall be anti-glare red with a smooth surface. No external screws or studs shall be visible on the bezel or clock housing.

5. The Digital Clock shall be recessed mounted. Provide backbox at all locations to electrical contractor for installation.

D. The Telecor 2463-D Analog Secondary Clocks are designed for use in conjunction with Telecor’s Master Clock, as well as Telecor microprocessor-base Administrative Communication Systems. When used with Telecor’s C5PPL, CAT 5 Patch Panels, the clock can be installed using CAT 5 cable.

1. These Analog Secondary Clocks are synchronous 3-wire units with a second hand to mark the fractions of a minute as well as the minute and hour hands. These clocks can be powered from either a 24 VAC or 24 VDC source. Provide and install clock power supplies in the local IDFs and MDF.

2. The 2463-D Model has a 16" diameter display and is housed in a low-profile, semiflush metal case designed for wall mounting. Provide at all C16 locations on the drawings. Provide 12" analog clock, model 2461-D, where noted on drawings.

3. The low profile design eliminates the need for custom backboxes and all clocks are designed to be mounted onto single gang electrical utility boxes.

4. Provide wire guards for all clocks in the gym and locker rooms. Wireguards shall be constructed of 3/32" diameter welded steel wire screen with 2" openings and 3/16" reinforced hoops. All joints are to be welded for strength and durability. The guards shall be finished in a rugged epoxy powder-coat finish, suitable for both indoor and outdoor environments.

PART 3—EXECUTION

3.1. EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify that required utilities are available, in proper location, and ready for use.

C. Beginning of installation means communications subcontractor accepts conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions, the communication subcontractor shall have equipment installed on the AC voltage supply, taking care to arrest damaging electrical transients and spikes that can cause damage to the microprocessor components of the system.

B. Install digital clocks as specified on the drawings and elevations. Where conflict occurs, notify the architect.

C. Install classroom and hallway loudspeakers into the suspended ceiling tiles.

F. Install and wire system in accordance with manufacturer's approved drawings and diagrams.

G. Provide and mount clock power supplies in IDF locations, and service via cable tray to classroom location. Coordinate with electrical subcontractor for all power requirements.

H. All cabling shall be installed in a neat, orderly and professional manner.

3.3 INTERFACE WITH OTHERS

A. All equipment shall be installed and connected in strict accordance with the manufacturer's recommended instructions.

B. Provide interface with telephone system.

C. Interface remote sound systems in Gymnaisum, Auditorium, Student Dining, storage/support/restroom facility, PE Alternative, classrooms, Press Box and small group seminar to provide program muting of these systems. Cordinate with 27 40 00 communication subcontractor.

D. Provide interface with access control system for lockdown purposes

3.4 FIELD QUALITY CONTROL

A. Provide field inspection and testing.

B. Perform operational test on each item of equipment and on system.

3.5 MANUFACTURER'S FIELD SERVICES

A. Observe installation of communications system.

B. Provide field technician services to make final signal cable connections to equipment.

C. Prepare and start systems.

3.6 ADJUSTING

A. Adjust controls and audio levels to achieve proper operations.

B. Set status of each classroom call-in device and other stations as indicated.

C. The specified equipment shall be supplied, installed, adjusted, tested, and guaranteed by a factory-authorized communication subcontractor for the products furnished. The communication subcontractor shall be responsible for verifying the completeness of the parts list and the suitability of the equipment to meet the intended purpose of the specifications and to serve the best interests of the owner.

3.7 DEMONSTRATION

A. Provide systems demonstration and instructions. Provide a minimum of 10 hours for PA and master clock systems. Provide the Owner with a training program designed to make all administrative control station users familiar with the operation of the voice communications and emergency notification and response system.

B. Employ manufacturer's field representative to demonstrate system operation to designated Owner personnel.

C. Use submitted operation and maintenance manual as reference during demonstration and training.

D. Submit field reports indicating satisfactory installation and testing of system.

F. All training materials shall be provided to the owner in digital format, and all training shall be video recorded and provided to the owner on DVDs.

3.8 WALK THROUGH

A. Conduct walking tour of project and describe function, operation, and maintenance of components. Provide volume adjustments as necessary to provide acceptable sound levels to the Owner.

END OF SECTION

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Section 27 70 00
VIDEO DISTRIBUTION SYSTEM
(FILED SUB-BID REQUIRED AS PART OF SECTION 26 00 01)

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

A. Sub-Bid Requirements: As provided under Section 26 00 01 – Electrical Filed Sub-Bid Requirements and supplemented under the Bidding Requirements, Contract Forms, and Conditions of the Contract, and applicable parts of Division 1 - General Requirements.

1. Work of this Filed Sub-Bid includes all individual specification sections listed in Section 26 00 01

1.2 RELATED DOCUMENTS

A. The General Provisions of a Contract, including conditions of the Contract and Division 1 of the Specifications, shall apply to the Work in this Section.

B. Drawings and general provisions of the Contract, including all portions of the Project Manual are hereby made a part of this Section. Refer to paragraph titled “Quality Assurance” in this section and to Division 1 for requirements for Communications Subcontractors. Throughout this and related Sections, “Subcontractor” shall not be limited to the singular and masculine and shall refer to one, or more than one, Communications Subcontractor. The Terms “Installer”, “Contractor”, “Communications Subcontractor” and “Communications System Integrator” shall be used interchangeably and shall be understood to represent the bidder responsible for the furnishing, configuring, testing, programming, warranting and ensuring all work is performed in accordance with manufacturer’s requirements and recommendations identified in this section.

C. Any qualifications or certificates required in this specification may be requested by the Architect as part of the post-bid qualifications review. Such review shall commence subsequent to the bid submission, as none of this information is required as part of the bid submission. In the event that the Architect requests qualification or certification documentation such documentation shall be provided within three (3) business days.

1.3 SUMMARY

A. Furnishing of all labor, project management, materials, tools, equipment, cabling, terminations and resources necessary for the complete installation of the IPTV Video Distribution System as specified herein.

B. All miscellaneous items and accessories required for a complete and functional installation, whether or not each such item or accessory as shown on the plans or mentioned in this specification shall be furnished and installed.

C. The Video Distribution System must consist of the following features that will be specified in detail below:

1. IPTV Video Distribution Headend and Mini Head end
2. Analog Media Playback Devices
3. Digital Video On Demand Server providing IPTV Streaming
4. RS232 Control System, providing classroom workstation control plus administrative control of RS232 LCD TVs and projectors. All inputs to the TVs and projectors shall be switchable from within the graphical user interface of the IPTV system.
5. Bulletin Board video information system with licenses for 6 streams. Ensure this device broadcasts in high definition.
6. HDMI and RS232 cabling (RS232 cable 9 conductor minimum) and terminations from STBs (STBs provided by the Owner, to be installed and re-programmed by subcontractor of this section) to the TVs (TVs provided and installed in this section, plus installation of five Owner provided 42” TVs and wall mounts).

    a. Install 93 Owner provided MM-1274 set top boxes. Cabling provided in 274000. RS232 cable provided by 274000 for these locations, however RS232 terminations provided and installed by communications subcontractor of this section.

    b. Install 3 MM-1272 set top boxes provided by Owner for the large format projectors (projectors installed by 274000 in Small Group Seminar, Auditorium Booth, Café). Provide all cabling required (RS232 and HDMI to projector in Café, HDMI cabling from set top box to local AV switcher and sound cable from set top box to local audio system input in Small Group Seminar and Auditorium Booth, and RS232 cabling to control system in Auditorium and Small Group Seminar). Coordinate connections to switchers and audio connections with 274000.

    c. Install 5 Owner provided 42” TVs and wall mounts, and 5 Owner provided MM-1272 set top boxes for these TVs (103G, 103F, 103E, 103C, 103B). Provide and install RS232 and HDMI cabling to each TV.

    d. Provide and install four 42” TVs with pole mounts in 271A and install 4 Owner provided MM-1272 set top boxes. Provide and install RS232 and HDMI cabling to each TV.

    e. Provide and install four 42” TVs with pole mounts in 147 and install 4 Owner provided MM-1272 set top boxes. Provide and install RS232 and HDMI cabling to each TV.

    f. Provide and install a 42” TV with wall mount in 100A and install 1 Owner provided MM-1272 set top boxes. Provide and install RS232 and HDMI cabling to TV.

    g. Provide and install a 42” TV with wall mount in 101A and install 1 Owner provided MM-1272 set top boxes. Provide and install RS232 and HDMI cabling to TV.

    h. Provide and install a 70” TV with wall mount in 101B and install 1 Owner provided MM-1272 set top boxes. Provide and install RS232 and HDMI cabling to TV.

i. Provide and install a 70” TV with wall mount in 145D and install 1 Owner provided MM-1272 set top boxes. Provide and install RS232 and HDMI cabling to TV.

j. Provide and install a 60” TV with wall mount in 169 and install 1 Owner provided MM-1272 set top boxes. Provide and install RS232 and HDMI cabling to TV.

7. Provide cabling from 9 IRD (CATV provider set top boxes if used) to encoders, and cabling from CATV service demarc to CATV IRDs.

8. IPTV delivery platform must be compatible with MAC as well as PC based computer systems.

9. The system shall include emergency broadcast capabilities to enable administrators to take over viewing/channel selection, with subsequent return to individual settings.

10. It is the responsibility of the communications subcontractor of this section to coordinate terminations and cabling required from T1, faceplates with 27 40 00 communications subcontractor to ensure proper projector control is provided via the T1 faceplate.

11. RG6 and RG11 as shown on IPTV drawings.

12. All projector and TV control shall be via RS232; all RS232 terminations to be provided and installed by the communications subcontractor of this section. Coordinate requirements with 274000 communications subcontractor to allow the STB to input to the control system in the auditorium, café and small group seminar to provide automatic emergency all calls over the projectors in those spaces. The 274000 communications subcontractor only provides the RS232 cable for interactive projector locations (communications subcontractor of this section is responsible for the terminations of these cables). All other RS232 cable to be provided by the communications subcontractor of this section.

13. Integrate the Plymouth North H.S. MediaMaster system with this project, to expand the system such that the North and South systems serve both schools by sharing their resources as a complete system. Provide all programming changes in the combined system for both locations, and any software and hardware required to provide the same functionality in both schools.

14. All IPTV components shall be from a single source manufacturer (MediaMaster by ETR), no off the shelf components shall be utilized in the system.

15. Panic button integration - provide and install 5 panic button (panic buttons and outputs from access control to the IPTV rack provided and installed by 28 13 00) inputs from access control to the IPTV system, program for automatic emergency all call as directed by Owner.

16. Provide and install all Cat6A patch cords required for network connectivity of devices. Patch cords for set top boxes must be Black. All other patch cords in the mini head end and head end shall be Red.

17. It is the intent of this specification that a complete and fully functional system is provided and installed. All miscellaneous items and accessories required for such installation, whether or not each such item or accessory is shown on the plans or listed in the specification, shall be furnished and installed.

D. No Ceiling spaces are air plenums. No cabling needs to be plenum rated.

1.4 RELATED WORK SPECIFIED ELSEWHERE

A. SECTION 26 00 00 – ELECTRICAL

B. SECTION 27 10 00 – STRUCTURED CABLING

C. SECTION 27 40 00 – AUDIO-VIDEO COMMUNICATIONS

D. SECTION 28 13 00 – ACCESS CONTROL

E. SECTION 05 31 00 – STEEL DECKING See for restrictions concerning the hanging of material, cable tray, mounts, brackets, hooks, and other items from the roof or decking.

F. SECTION 01 23 00 – ALTERNATES

1.5 SYSTEM DESCRIPTION

A. Specified Manufacturer: To establish a standard of quality, design and function desired, Drawings and specifications have been based on the MediaMaster equipment by Educational Technology Resources, listed below:

Manufacturer	Item	Part Number
ETR	MEDIASERVER WITH VOD	MM-3000D
ETR	NETWORKED VIDEO RECORDER	MM-1138
ETR	PRESTO VIDEO	MM-1142
ETR	BULLETIN BOARD	MM-8100PV
ETR	ADDRESSABLE MEDIA CONTROLLER	MM-1210
ETR	UNIFIED DVD/VCR	MM-1211
ETR	INFRARED EMITTER	MM-1202
ETR	BLADE ENCODER SYSTEM CHASSIS	MM-1287
ETR	HIGH DEFINITION ENCODER BLADE	MM-1288H4
ETR	1 CHANNEL HD PORTABLE MPEG ENCODER	MM-1288H4C
ETR	SOFTWARE	

B. Acceptable Substitutions: The product(s) specified above have been determined to be in the public interest based on sound reasoning and voted as proprietary by the Owner. Under provisions of Massachusetts General Laws, Chapter 30, Section 39M(b) and Chapter 149, other equal products not named herein, may be considered for acceptance as an equal by the Architect and Owner upon submission of complete product information as described in Section 01 25 13 - Product Substitution Procedures. Further additional information may be requested by the Owner or Architect for determination that the proposed product substitution is fully equal to the specified product(s). There is no guarantee that proposed substitutions will be approved, and the Communications Subcontractor shall not to order any materials until approval(s) are received in writing.

1. Requesting substitutions shall be at the Communications Subcontractor's own risk, with regard to uncompensated delays of the Project. Time will be required for sufficient review and additional requests for information by the Architect and Owner. Delays which result from substitution reviews and resubmissions are not grounds for additional time or cost change orders, and will not be considered by the Awarding Authority.

C. Performance Requirements

1. Maintain the school's IPTV system including forward and reverse broadcasting.

   a. Forward Operations: Distribution of 11 min and 135 max incoming CATV channels on 9 digital video channels. Distribution of 2 VCR/DVD combo units. All DVD/VCR units must be IR controllable from the network.

   b. Reverse Operations: Remote origination of video feed using a mobile encoder for multicasting via the IPTV system.

   c. Ensure overall performance of video distribution system does not interfere with CATV service provider's operations.

2. CATV service shall be connected to new head-end equipment. The Owner shall provide 9 IRD boxes from CATV service provider if required. Coordinate IRD quantities with Owner and Owner's CATV service provider. Provide splitter/amplifier/taps of appropriate type to split and amplify the CATV service providers feed as shown on the drawings.

3. Provide every required part of system complete in detail and operable in unison with all other sections of this specification, resulting in a complete IPTV video distribution system.

4. Provide all work, materials, and manner of placement in strict accordance with requirements of latest edition of National Electrical Code.

5. Provide all materials listed as complying with available standards of Underwriter's laboratories or other similarly established standards and carry their label. Apply all materials in strict accordance with Underwriter's laboratories listing.

6. All work described in this Section performed by a manufacturer certified communications subcontractor. Bidder shall provide proof of manufacturer certification.

1.6 SUBMITTALS

A. Architect may require submittal submission within 45 days of bid award. Submit the following under provisions of Section 01 33 00 - SUBMITTAL PROCEDURES with tabulated and indexed pages. Show reference to specification section in index. Any submittals received non-tabulated or indexed shall be returned without action.

B. Manufacturer's Data:

1. Submit:

   a. Product Data Sheets

   b. Installation Instructions

2. Manufacturer Certificate and Certified Training Certificates of communications subcontractor who will be providing, programming and warranting the equipment.

C. Shop Drawings:

1. Submit three (3) digital copies in AutoCAD 2010 or later on a CD of shop drawings, including:

    a. Layout of equipment on supplied AutoCAD drawings, include labeled wiring risers showing all equipment.

    b. Rack elevation drawings

    c. Equipment locations

    d. Detailed wiring diagrams (as-builts) of data ports used to connect set top boxes, TVs, and projectors. Diagrams shall include VLAN identification information. Include patch panel numbers in the IDFs and MDF for ports used for projectors, TVs and set top boxes. Label all patch panel ports if not labeled, designating projectors (P), set top boxes (S) and TVs (T).

D. Closeout Submittals:

1. As-Built Drawings: Update Shop Drawings to create final As-Built Drawings. Submit three (3) copies digitally in AutoCAD 2010 or later format on a CD.

2. Operation Data: Include three (3) copies of the software Administrator and Operator Manuals.

3. Maintenance Data: Include three (3) copies: maintenance and repair procedures.

4. Digital copies of all training materials and DVD videos of all training provided on CD and DVDs.

5. Estimated costs for maintenance and software assurance for the system on a yearly basis.

6. Submit an all-inclusive Annual Maintenance Agreement and software assurance agreement cost for years 4 and 5, in the close out submittals

7. Warranty certificate with contact numbers with appropriate start and stop dates.

8. PDF of product data and O&M manuals shall contain bookmarks for every section and item submitted.

1.7 QUALITY ASSURANCE

A. Manufacturers: Manufacturer shall be a single-source manufacturer for the system, that specializes in IPTV with a minimum of five (5) years in the industry.

B. Communication Subcontractor: Company specializing in IPTV and Audio Visual Systems with a minimum of five years experience on the MediaMaster system of similar size and scope. Communications subcontractors working on project must have been certified by the manufacturers on the hardware and software used for this project. Provide valid current proof of manufacturer's certification.

C. Propriety Specification: The awarding authority has voted the Educational Technology Resources MediaMaster System and related components as a propriety product for this section to maintain compatibility with existing District infrastructure. Communications subcontractors must be certified by ETR to provide, install, configure, test and warrant the MediaMaster system.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver all materials to be stored on site in their original protective containers. Clearly mark all material containers to indicate project name, number and Manufacturer's / Communications subcontractor's name.

B. Distribute any material stored in building to prevent blocking of passageways and as directed by Owner, Project Manager or Architect. Do not store material in building without Owner's prior approval.

1.9 WARRANTY AND SERVICE AGREEMENT

A. All equipment, materials, and labor shall be guaranteed for a period of thirty-six (36) months from the date of final acceptance by the Owner. Warranty shall begin at this time, not the date of substantial completion. Systems must be fully operational, and accepted by the Owner after training before the warranty is to begin. Three (3) year warranty shall cover the complete system and all components, in both the North and South Schools. This shall include all software assurance for three (3) years in both locations. Warranty shall include all travel expenses.

B. The manufacturer or communications subcontractor shall repair or replace malfunctioning products at no expense to the Owner, except failures caused by damage or unreasonable use.

C. Communications subcontractor shall maintain regular service facilities and a help desk. Provide qualified technicians that are experts in IPTV, LAN/WAN design and support, and AV control, and who are familiar with the work at the site, within twenty-four (24) hours of receipt of a notice of malfunction, excluding weekends and holidays. Coordinate all VLAN, port and switching configurations required with the Owner (Switching equipment provided by Owner).

1. Provide material, devices, equipment, and personnel necessary for repairs.

D. Provide accepted temporary, alternate equipment, if required by the Owner, complete and operational within forty-eight (48) hours after notification of malfunction, at no additional cost during the first year of warranty.

E. Communications subcontractor shall conduct warranty repairs and service at the project site unless prohibited by manufacturer's warranty. If the latter, communications subcontractor shall provide substitute systems, equipment, and devices acceptable to the Owner for the duration of the off-site repairs. Replace items out of service more than ten (10) days with new equipment during the warranty period.

F. Communications subcontractor shall transport warranty equipment, substitute systems, test systems, equipment, devices, materials, parts, and personnel to and from the project site at no additional cost to the Owner.

G. Provide any software maintenance updates or upgrades to all systems at no additional cost to the Owner for this thirty-six (36) month period.

H. Response Times - Normal business hours shall be 7:00 a.m. to 5:00 p.m., Monday through Friday. Calls for service before noon shall be responded to on-site before the end of the day. Calls after noon shall be responded to on-site by noon the following business day.

I. Provide extra costs for time outside of normal business hours if the Owner requires emergency service.

J. Submit normal and after hours labor costs and typical costs for equipment for items not covered under the Warranty, like: Acts of God, vandalism, misuse.

1.10 MAINTENANCE

A. Service Calls: Provide twenty-four (24) hours of service calls on system for the school after final acceptance to make any adjustments necessary to keep system at peak operating condition. Warranty work is not included in the service call time.

1.11 ALTERNATES

A. Alternate 2 – Storage/Support/Restroom Facility. All related work on T2.4 for the facility shall not be included in the base bid. This work shall be included in the ALTERNATE 2 bid.

PART 2 – PRODUCTS

2.0 IPTV VIDEO DISTRIBUTION SYSTEM

A. Specified Manufacturer: To establish a standard of quality, design and function desired, Drawings and specifications have been based on the MediaMaster equipment by Educational Technology Resources.

Manufacturer	Item	Part Number	Qty
ETR	MEDIASERVER & VOD	MM-3000D	1
ETR	NETWORKED VIDEO RECORDER	MM-1138	1
ETR	PRESTO VIDEO LICENSE	MM-1142	6
ETR	BULLETIN BOARD WITH 6 LICENSES	MM-8100PV	1
ETR	ADDRESSABLE MEDIA CONTROLLER	MM-1210	3
ETR	UNIFIED DVD/VCR	MM-1211	2
ETR	INFRARED EMITTER	MM-1202	11
ETR	BLADE ENCODER SYSTEM CHASSIS	MM-1287	1
ETR	HIGH DEFINITION ENCODER BLADE	MM-1288H4	9
ETR	1 CHANNEL HD PORTABLE ENCODER	MM-1288H4C	3
ETR	SOFTWARE		

B. Acceptable Substitutions: The product(s) specified above have been determined to be in the public interest based on sound reasoning and voted as proprietary by the Owner. Under provisions of Massachusetts General Laws, Chapter 30, Section 39M(b) and Chapter 149, other equal products not named herein, may be considered for acceptance as an equal by the Architect and Owner upon submission of complete product information as described in Section 01 25 13 - Product Substitution Procedures. Further additional information may be requested by the Owner or Architect for determination that the proposed product substitution is fully equal to the specified product(s). There is no guarantee that proposed substitutions will be approved, and the Communications Subcontractor shall not to order any materials until approval(s) are received in writing.

1. Requesting substitutions shall be at the Communications Subcontractor's own risk, with regard to uncompensated delays of the Project. Time will be required for sufficient review and additional requests for information by the Architect and Owner. Delays which result from substitution reviews and resubmissions are not grounds for additional time or cost change orders, and will not be considered by the Awarding Authority.

2.1 MEDIASERVER

A. The MediaServer shall consist of, but not be limited to, the following:

1. The MediaServer shall be located in MDF in an 84" enclosed media cabinet to keep it clean and prevent bumping and jarring. It shall feature forced-air cooling. Cooling air shall be drawn through a front cleanable filter and exhausted out of the rear of the case. The rack mount case shall be constructed to provide adequate airflow over all components. Provide and install rack where shown on the drawings.
2. The MediaServer shall minimally consist of:
   a. Minimum Intel Dual Core 3.6 GHz CPU with 8GB of ECC RAM based server unit with dual 1GB Ethernet NICs.
   b. Minimum 25TB useable hard disk storage (if the Digital Video Server is included), protected by a RAID-5 array and controller with battery backup module, and RAID array with swappable drives and redundant power supplies and hot swap configured spare drive installed.
   c. MPEG1&2, H.264 and HTML5 video in high resolution bit rates up to 16Mb.
   d. Install all components in the MDF head end room.
   e. Systems incapable of TCP/IP control will not be considered equivalent.
   f. The Digital Video On Demand Server may be encompassed with the MediaServer.
   g. The VOD server shall be NAS compatible to accommodate future content storage.
3. The operating system shall be Linux, a multitasking TCP/IP capable OS. It shall communicate over TCP/IP without modification. It shall be compatible with all client operating systems and software.
4. The MediaServer shall communicate with all classroom PC or Macintosh workstations simultaneously. The architecture shall be browser based. The communication link will provide teachers with schedule updates in real time as they occur. Teacher (client) login to server shall take no longer than three (3) seconds.
5. The MediaServer shall bi-directionally communicate individually or globally with Ethernet Projectors and TVs, Ethernet Tri-band Tuners, RS232 Plasma Displays, RS232 LCD Displays, RS232 TV Tuners, Ethernet Television Control Units (ACI), RS232 Television Control Units (CCM), RS422 Television Control Units (CCM), and Ethernet Media Control Modules (ACM), via TCP/IP over a Local Area Network, Wide Area Ethernet Network, and or Internet.
6. The MediaServer must support remote maintenance and upgrades of the Server software and all other video on demand software. No system will be accepted that requires onsite service as the primary means of updating and providing software fixes and releases. The District shall grant secure firewall permissions for remote login and diagnostics of the MediaServer. The multi-tasking MediaServer must

continue to operate in a fully functioning mode while remote login and diagnostics are being performed. This architecture allows accurate system diagnosis under fully "loaded" conditions via the network, or the Internet. Systems that require users to disconnect or normal functioning to cease during remote login and diagnostics shall be unacceptable.

7. The MediaServer shall be a wholly graphical based, user-friendly system for configuration and diagnostic maintenance. Systems, which use character based configuration utilities, will be unacceptable.
8. The MediaServer shall globally administrator preprogrammed/automatic TV and projector Power Down during non-authorized hours for energy and lamp conservation. After the global Power Down, TVs and or projectors may again be permitted for use during evening activities.
9. The MediaServer shall disable front panel controls on MediaMaster Network Certified TVs and or projectors. In this mode teachers and students cannot manually control TV and projector use. MediaMaster shall be the only method of local or global control. This is a mandatory feature in public or common spaces.
10. The MediaServer must constantly poll and receive current status from the networked TV displays. Systems which periodically send a power off command are not acceptable.
11. The MediaServer with shall administrator Video All Call and Video Zone Page announcements. Quantity of Video Paging Zones shall be unlimited. Configuration shall be graphically based and user-friendly. All video monitors in the School will be remotely powered on/off and controlled using this software and hardware feature. The system administrator can see in real time that displays are On, Off, Not Communicating, what input has been selected on the TV or projector, what channel a teacher is viewing, or have images from their workstation displayed.
12. The MediaServer shall include Playlist software. Playlist allows any zone of TVs and or projectors to be Powered On, tuned to a CATV channel, or play one or many MPEG titles from the Digital Video Server. The Playlist is a pre-programmed automated event that can occur one time, or repeat as many times as desired, at any time. When the Playlist event is finished TVs and or projectors and projectrs are returned to their state prior to the automated Playlist event. Multiple Playlist events can be pre-scheduled. Typical applications include Bulletin Board, Weather Channel, News Channel broadcasts to Lobbies and Cafeterias. Daily applications such as The School's Morning News Broadcast can be pre-encoded and auto-play during the pre-scheduled Playlist event. Special events, like a digital title playing on the Cafeteria TVs and or projectors for an after hours group between 7:00 p.m. and 8:00 p.m. can be easily accommodated.
13. The MediaServer shall automatically produce a graphically based Menu Channel, which can be broadcast over the schools IPTV distribution system. Via an asynchronous communication link, the MediaServer with Digital Video Server shall be constantly updated by teachers' using their MediaScheduler software. The MediaServer shall be supplied with a composite video output and video/audio channel modulator.
14. The operating system shall be able to support an unlimited number of TCP/IP connections.
15. The MediaServer shall include dual 1GB NIC ports. The operating system shall support multiple IP addresses simultaneously. This feature allows Intranet IP addressing to be combined with Internet IP addressing, and VLANs.

16. The MediaServer shall not use any proprietary network topology to communicate with other workstations to perform media control and/or scheduling functions. Systems that require multiple workstations to control and/or schedule media playback devices are unacceptable.

17. The MediaServer shall contain and maintain all configuration databases as well as scheduled event data. All PC and Macintosh workstations on the LAN shall have access to the MediaServer databases via MediaController, MediaScheduler, MediaAdmin as well as common FTP and Telnet connections. The MediaServer shall allow password protection at varying levels.

18. The operating system shall support a minimum of 1024 serial port connections, allowing search capability and serial control of every VCR, DVD, LDP, Macintosh and PC in the Media Center head-end. The system shall control base band video routers and/or broadband video networks.

19. The MediaServer should provide reporting capabilities on the usage of the system. The minimum reporting should be:

    a. How many times is a particular video source scheduled and used.

    b. How often a media title is scheduled and used.

    c. How often a particular teacher uses Programming on Demand Controller.

    d. What titles a particular teacher has scheduled during a specific period of time.

    e. What room locations use the system most frequently.

    f. Reporting shall be ad-hoc with media administrators being able to customize reports.

20. The District shall supply two 1GB data ports and static IPs, the Communications Subcontractor of this section shall supply and install two CAT6A data cables.

21. The MediaServer shall be configured for school lockdown scenarios in the following manner:

    a. The server shall accept 5 contact closure inputs from the access control system (28 13 00).

    b. The 28 13 00 Communications subcontractor shall provide 5 relay outputs and wire to the Communications Subcontractor of this section. Communications Subcontractor of this section shall install realy output to media server input.

    c. Upon contact closure, the media server shall control all projectors and TVs in the school and present a video file (up to 5 independent video files if desired) from the VOD server as per Owner direction. Provide all programming to accomplish Owner's desired lockdown procedure/event. Size content to properly display on all projectors and TVs.

    d. Provide a shortcut on the desktop of admin personnel (as determined by the Owner) to accomplish this same procedure via a desktop shotcut. Label this shortcut as per Owner direction. Provide this shortcut within a folder on the desktop to avoid accidentally initiating a lockdown.

22. Browser based MediaServer shall be the MM-3000-D MediaMaster Streaming Video on Demand WebServer by ETR, or equal. It shall be rack mounted in the MDF headend. The MediaServer and Digital Video Server may be separate units,

however the Digital Video Server must contain a minimum 25TB storage in the above configuration if not part of the MediaServer.

2.2 UNINTERRUPTIBLE POWER SUPPLY (UPS) – PROVIDE 2

A. Provide a full-time, perpetually on-line UPS system providing sine wave correction, voltage regulation, spike suppression, and a minimum of 20 minutes backup power. Standby UPS systems are not acceptable.

B. The UPS must be capable of interfacing to the MediaServer with Digital Video Server with an alarm function to enable an orderly shut down prior to complete loss of power.

C. One large UPS shall serve the MDF headend, one in the mini-headend

D. UPS for Head End shall have a 120v 30 amp twist lock plug. UPS for Mini Head End shall have a standard plug.

E. Provide UPS systems as manufactured by Para Systems, Liebert, Sola, Tripplite, or equal.

2.3 DIGITAL VIDEO SERVER

A. The Digital Video Server shall consist of, but not be limited to, the following:

1. Central video service will be provided via an MPEG1, 2, H.264, HTML5 multicast based Video on Demand Digital Video Server. In addition to the Video on Demand file server with mass storage, the system shall support an analog to digital encoding/DV encoding system.

2. The Video on Demand Digital Video Server unit will provide playback of motion video sources. The server shall transcode and store motion video signals in MPEG1, 2, H.264, HTML5 multicast formats on multiple redundant hard drives and deliver video via the School's IGMP enabled network to PCs and MACs, and to TVs and projectors with decoders that convert the MPEG signal into an HDMI digital audio/video signal. The unit will consist of one integrated server. Video-on-Demand Digital Video Server:

   a. Minimum Intel 64 bit QuadCore based server unit with dual 1GB Ethernet NICs.

   b. Content shall be protected by a RAID-5 array and controller.

   c. District owned content shall reside on multiple hot swappable hard drives with 25TB minimum capacity. Operating system shall reside on independent 1TB drive.

   d. MPEG1&2 video in high resolution bit rates up to 20Mb 1920 x 1080 resolution with 30 FPS each.

   e. Redundant power supplies shall be provided.

   f. Install all components in locking cabinet in the head end room.

   g. Systems incapable of TCP/IP control will not be considered equivalent.

   h. The Digital Video On Demand Server may be encompassed within the MediaServer.

3. The DVS shall be capable of delivering unlimited Multicast digital video streams over the School's network. VLC Player with MPEG decoder is supported for

teacher playback. The District will provide adequate and prioritized bandwidth for this application.

4. For RF applications the Video on Demand Server shall allow every teacher to uniquely Bookmark any District owned video. A Jump To button shall be included, and when selected shall trigger an instant viewing of a scene essential to the teacher's lesson.
5. The District shall supply two 1GB data ports configured for IGMP Snooping and 2 static IPs. The communications subcontractor shall supply and install CAT6A data cables.
6. The MM-3000-D MediaMaster Streaming Video WebServer shall be by ETR, or equal.

2.4 NETWORKED DIGITAL VIDEO RECORDER SERVER

A. The Digital Video Recorder Server shall consist of, but not be limited to, the following:

1. The NVR is an integrated package allowing the School to manually or automatically encode video from tapes, discs, DirecTV, CATV, Live Encoders, and Bulletin Boards onto the Digital Video on Demand Server with automatic Title Database Update. The system includes the following components and capacities:

   a. At a minimum: Case shall be full format to permit full size PCI and PCIE cards, and 2 memory slots. System Processor shall be Intel Core2Duo 3.4GHz. Memory shall be 1.0 GB, 800 MHz DDR2. Hard drive shall be 3TB SATA, 3.0GB/S. Mouse shall be optical with USB connector. Integrated 1GB NIC Port.

   b. Operating system shall be Linux preloaded. No free trial software shall be loaded.

   c. Hardware and MediaRecorder software to transfer encoded files to the Digital Video Server, and simultaneously transfer metadata to the Title Database for search and immediate on

   d. Ability to preview and cue the video and audio source.

   e. The intuitive encoding process shall not require a full time attendant, and be available to any User with MediaRecorder Administrative Rights.

   f. A Web based TV Guide shall be included.

   g. Encoding format shall be H.264 HD Transport Stream to allow any video to be multicast to every TV and projector simultaneously.

   h. The District requires the ability to immediately encode, or preschedule online encoding of 24 simultaneous DirecTV, CATV, DVD, VHS, or Live Multicasts broadcasts during school hours, evenings, and or weekends. Every stream shall simultaneously be viewable by teachers and administrators during the encode process, without interruption.

   i. Install the preconfigured NVR in the MDF headend. The District will supply network settings.

B. The District shall supply a 1000MB data port configured for DHCP and IGMP Snooping. The communications subcontractor shall supply and install a CAT6A patch cable.

C. The Networked Digital Video Recorder with all peripherals shall be the MediaMaster MM-1138 MediaRecorder by ETR, or equal.

2.5 HIGH DEFINITION PRESTOVIDEO BULLETIN BOARD PC (Provide 1 with 6 licenses.)

A. The Bulletin Board is an automated high definition visual message package allowing the School to create and display important information for staff, students, and community. At a minimum the system includes the following components and capacities:

1. Rack mounted case shall be full format to permit full size PCI and PCIE cards, and 2 memory slots.
2. System Processor shall be Intel Core7 3.2GHz.
3. Memory shall be 4.0 GB, 800 MHz DDR2.
4. Hard drive shall be 3 TB SATA, 3.0GB/S.
5. 2 Front and 4 rear USB connectors.
6. Supports PS2 or USB mouse and keyboards.
7. DVD reader shall be 16X. Integrated 10/100MB NIC Port.
8. A full size Composite Video and S-Video Out card shall be installed and preconfigured.
9. HDMI, VGA, and Composite Out shall be included.
10. Operating system shall be Microsoft Windows 8 preloaded.
11. Graphics software shall be Windows PowerPoint preloaded.
12. No free trial software shall be loaded.
13. Full 1080p output.

B. The Bulletin Board shall be configured for password protected remote access by department personnel that need to display information: District Administration, School Administration, Athletics, Arts, Food Service, Clubs, Departments, and Vo-Tech.

C. The Bulletin Board shall be preloaded with PrestoVideo PowerPoint to H.264TS Transcoding software licensed for 24 simultaneous transcodes, file loads, or transfers. Transcode shall take no longer than the duration of the PowerPoint. Real time status shall be provided. PrestoVideo shall automatically transfer presentation file metadata to the VOD Server Title Database upon completion of the transcode process.

D. The Bulletin Board shall operate in concert with MediaMaster Playlist. Playlist allows the Video On Demand System to function as an automated broadcast system. Any zone of TVs and or projectors may be Powered ON, tuned to the Bulletin Board Channel. The quantity of TVs and or projectors in any Playlist Zone is unlimited. Playlist shall control zones of TV and projectors intuitively organized by columns and rows and selected by check box.

E. The Playlist is a pre-programmed automated event that can occur one time, or repeat as many times as desired, at any time. When the Playlist event is finished TVs and or projectors are returned to their state prior to the automated Playlist event. Multiple Playlist events can be pre-scheduled.

F. The Playlist shall have the ability to Power On all TVs and projectors and display the Bulletin Board every morning during homeroom. Students in Visual Communications Program shall have the ability to switch all TVs and Projectors from the Bulletin Board Channel to the TV Studio Channel when they are ready to broadcast.

G. The Bulletin Board shall output all presentation streams in 1080p high definition.

H. The HDMI port shall be connected to the rack mounted PC/TV monitor.

I. The District shall supply a 1000MB data port configured for DHCP and IGMP Snooping. The communications subcontractor shall supply and install a CAT6A patch cable.

J. The 6 Bulletin Board licenses with all peripherals shall be the MediaMaster MM-8100PV PrestoVideo Bulletin Board by ETR, or equal.

2.6 MEDIASERVER ADMINISTRATOR SOFTWARE

A. The MediaServer Administrator software shall consist of, but not be limited to, the following:

1. The MediaServer Administrator software shall provide a graphical representation of all administrator functions required by the Video On Demand system.
2. The MediaServer Administrator software shall provide password-protected access to the administrator functions. Only personnel with administrative permissions can access this software.
3. The MediaServer Administrator software shall be Web based.
4. The MediaServer Administrator shall provide for the following administrative functions:
   a. Adding, deleting, and editing User information.
   b. Adding, deleting, and editing media Title information.
   c. Adding, deleting, and editing scheduled Event information.
   d. Adding, deleting, and editing Room information.
   e. Adding, deleting, and editing Source information.
   f. Adding, deleting, and editing TV and projector control configurations.
   g. Logging projector lamp usage and printing reports.
   h. Logging video usage and printing reports.
   i. Logging projector and TV IP addresses, manufacturer, model number, and printing reports.
   j. Automated shutdown of every TV and projector for daily energy conservation or a lock down.
   k. Automated power on and shutdown of every TV and projector for zone or all global pages.
   l. Manual override & shutdown of every TV and projector for a lock down.
   m. Manual power on and shutdown of every TV and projector for zone or all global pages.

B. The MediaServer Administrator software shall provide Zone Page functions. Zone paging is defined as the ability for media administrators to selectively power on and off TVs and or projectors in the LAN, WAN, MAN, and Internet environment. The Zone Paging function shall have the following minimum functions:

1. Create and edit an unlimited amount of zones.
2. Display the current status of every TV in every zone. MediaServer Administrator software shall poll and receive status from the networked TVs and or projectors. The software will then display a Gray TV for Off, a Blue TV if On, and a Red TV if there is a problem. It shall also display what input or channel is being viewed in every room.
3. For every projector the Zone screen shall show accrued lamp and filter usage to allow proactive maintenance. Lamp status is imperative for yearly maintenance budgeting.
4. Allow individual control of any classroom TV with the MediaServer Administrator software. This includes Power, Volume, Channel, Mute and Input source control.
5. The software shall be capable of manually selecting any zone, selecting a channel for the video zone page, and powering TVs and or projectors on for the duration of the broadcast. TVs and or projectors that were off prior to the video page will power off following the page. TVs and or projectors that were on prior to the page will remain powered on and return to original channel or input previously viewed.
6. Using the MediaServer Playlist software, the system shall be capable of prescheduling Zone Pages. This function shall include scheduling TVs and or projectors to power on and off, selecting the appropriate channel for the TVs and or projectors in that zone, and scheduling videos to automatically play. TVs and or projectors that were off prior to the prescheduled video page will power off following the page. TVs and or projectors that were powered on prior to the prescheduled video page will remain on and return to original channel being viewed.
7. The MediaServer Administrator software, in conjunction with the ACI, shall be capable of displaying the status of a motion detector (PIR) from the ACI. The Programming on demand Administrator software shall then be capable of sending a message to an addressable security system that motion in that room location was detected.
8. Located under the System tab, the Load Marc Records field allows the user to Import MARC 21 library format files from most library systems. The Load function allows the user to add to the end of the title database or to overwrite the existing title database.
9. Located under the Period tab, the MediaServer Administrator provides the ability to define the beginning and end of an unlimited quantity of school periods. Defining periods allows teachers using MediaScheduler to schedule by period. Or, the School may prefer to schedule by time, which the system also allows.
10. Located under the Channels tab, the MediaServer Administrator provides the ability to build a complete channel lineup. Only the preferred channels are identified, assigned a channel number, assigned a channel icon from a built in database of national logos and or downloaded from a remote database. Once the Channel is fully defined, MediaController users simply point and click on the History Channel icon and the TV tunes to the appropriate channel. Teachers who reside outside the

School's local CATV service provider's franchise need not be familiar with the numerical channel lineup, they simply click the familiar icon of the channel they desire. Systems without icon based channel control require additional teacher training and are therefore deemed inferior. Software based Channel configuration is a mandatory requirement to allow cherry picking available channels on a temporary or permanent basis without using expensive RF filters or processor hardware.

11. The MediaServer shall include MyChannel software. MyChannel shall administer the configuration, management, exclusion, and monitoring of CATV, DirecTV, and in-house broadcast channels. It shall include a database of full color bitmaps of all of the School's currently available broadcaster logos and allow easy import of new bitmaps as new stations come online. This feature allows the District to create pages of available and authorized channels. It shall not be necessary for teachers to know the CATV or DirecTV channel number, they shall simply select the bitmap logo of the broadcaster they desire. If the teacher wants to stream the channel or broadcast to their desktop or laptop computer, the MediaServer will automatically open a software player/decoder and play the stream. If the teacher wants to stream the channel or broadcast to their projector or TV, the MediaServer will automatically command the MM-1274T hardware to decode the stream, power the projector or TV On, then switch input to HDMI, component, or VGA to view the stream. MyChannel shall work in concert with the MM-1210 ACM.

12. Located under the Sessions tab, the MediaServer Administrator provides the ability to view all users logged into MediaMaster. The Administrator can view a snapshot of what every teacher is doing and can log any user off the system if required.

C. Located under the Sources tab, the MediaServer Administrator provides the ability to define what analog and digital playback sources teachers can control via MediaController. Buttons can be added or deleted based on capability of the playback source, or by what permissions the School allows. For example - A DVD power button would allow teachers to power down the DVD player and cause conflict with the next scheduled teacher. Thus, the Power button is simply not enabled on the Source Control palate. Another example - Record is a capability of VCRs, but if added and selected by a teacher, he/she could accidentally erase a tape.

1. MediaServer Administrator also allows configuration of DVD players for Advanced DVD Control. Newer DVDs now feature chapter, frame, language, menu, etc. selections. Systems without Advanced DVD Control preclude teachers from using many educational DVDs that are now provided with Laser Disk like features, and are therefore deemed inferior.

2. Located under the System tab, the MediaServer Administrator provides the ability to force TVs and projectors off at a predefined time, and keep them off. This feature is primarily used for energy conservation and prolonging projector lamp and TV life, but also serves to prevent evening occupants from watching TV for non-educational purposes.

3. The user-friendly MediaServer Administrative browser software shall be the MM-1185 MediaMaster Administrator product by ETR, or equal.

2.7 MEDIA PLAYLIST BROWSER SOFTWARE

A. The Media Playlist Browser Software shall consist of, but not be limited to the following:

1. Playlist allows the Video On Demand System to function as an automated broadcast system. Any zone of TVs and or projectors to be Powered ON, tuned to a Bulletin Board or CATV channel, or play an MPEG title from the Digital Video Server. The quantity of zones shall be infinite. The quantity of TVs and or projectors in any zones is unlimited. New Zones are easily created, and TVs and or projectors are added by simply selecting them via checkbox.
2. The Playlist is a pre-programmed automated event that can occur one time, or repeat as many times as desired, at any time. When the Playlist event is finished TVs and or projectors are returned to their state prior to the automated Playlist event. Multiple Playlist events can be pre-scheduled.
3. Typical daily Playlist events include Bulletin Board, Weather Channel, News Channel broadcasts to Lobbies, Cafeterias, and other common spaces. Recurring events such as The School's Morning News Broadcast can be pre-encoded and auto-play during the pre-scheduled Playlist event.
4. Special events such as playing a requested digital title on specific TVs and or projectors at specified times can be easily accommodated without media personnel present. Multiple titles can be stacked in a Playlist to allow continuous broadcasting.
5. The Media Playlist Browser software shall provide password-protected access to the administrator functions. Only personnel with administrative permissions can access this software.
6. The Media Playlist Browser software shall NOT require additional browsers or interpreters to be installed as a prerequisite for operation.
7. The Media Playlist Browser software shall use asynchronous messaging and must graphically display system changes as they occur. Systems, which periodically poll for system update and status information, are not acceptable.
8. The Media Playlist Browser software shall support access to other Media Title Databases available on the LAN, the WAN or via the Internet.
9. The media playlist creations browser software shall be the MediaMaster MM-1160 Playlist by ETR, or equal.

2.8 MEDIACONTROLLER BROWSER SOFTWARE

A. The MediaController Browser software shall consist of, but not be limited to the following:

1. The user-friendly MediaController Browser software shall provide a graphical representation of all digital, analog, CATV, Bulletin Boards, and local origination broadcast resources to an instructor on one or many PCs and Macs in the classroom.
2. The MediaController Browser software shall communicate with all other components in the system via TCP/IP over the LAN and WAN.
3. The MediaController Browser software shall provide password-protected access to the administrator functions. Only personnel with teacher or administrative permissions can access this software.
4. The MediaController Browser software shall not require additional browsers, plug ins, or interpreters to be installed as a prerequisite for operation.

5. The MediaController Browser software shall use asynchronous messaging and must graphically display system changes as they occur. For example: Ms Smith in room 100 is logged in to the Controller screen and would like to use a VCR. While she is deciding Mr. Jones logs in as room 102 and selects VCR2 for use. Ms. Smith immediately sees an in-use “sticky note” placed on VCR2. The sticky note also informs Ms. Smith that it was Mr. Jones who selected the VCR for use.
6. The MediaController Browser software shall provide graphical icons for every cable TV channels, DirecTV, and in house broadcast channels available to the instructor.
7. The MediaController Browser software shall control all video monitor functions such as Power On/Off, Volume Up/Down, Mute, Channel Up/Down, PC, TV Tuner, VGA2, HDMI, and Local Video inputs.
8. Upon logging in to the MediaController Browser software, the instructor shall be given immediate control of all sources scheduled for the current time period.
9. The MediaServer Administrator software shall provide a graphical representation of all administrator functions required by the Video On Demand system.
10. The media control browser software shall be the MM-1150 MediaMaster MediaController by ETR, or equal.

2.9 MEDIASCHEDULER BROWSER SOFTWARE

A. The MediaScheduler Browser software shall consist of, but not be limited to, the following:

1. The MediaScheduler Browser software shall provide a graphical representation of all digital and analog media resources to an instructor on one or many PCs and Macs in the classroom.
2. The MediaScheduler Browser software shall communicate with all other components in the system via TCP/IP over the LAN or WAN.
3. The MediaScheduler Browser software shall provide password-protected access to all media resources. Only personnel with teacher or administrative permissions can access this software.
4. The MediaScheduler Browser software shall NOT require additional browsers, plug ins, or interpreters to be installed as a prerequisite for operation.
5. The MediaScheduler Browser software shall use asynchronous messaging and must graphically display system changes as they occur. For example: Ms. Smith in Room 100 is logged in to the Scheduler screen and would like to schedule a Title from the Title database. While she is deciding Mr. Jones logs in as Room 102 and schedules the same title. Ms. Smith immediately sees a graphical representation of when and where Mr. Jones has scheduled the title.
6. Systems that periodically poll for system update and status information are not acceptable.
7. The MediaScheduler Browser software shall support access to other Media Title Databases available on the LAN, the WAN or via the Internet.
8. The media scheduling browser software shall be the MM-1155 MediaMaster MediaScheduler by ETR, or equal.

2.10 MEDIA MENU CHANNEL

A. The independent Media Menu channel shall be continuously broadcast School wide via the video distribution system to provide teachers and students accurate information about video broadcasts. The scrolling menu channel is a NTSC representation of the most current video schedule.

B. The graphically based Media Menu channel shall be automatically produced by the MediaServer and shall not require human intervention.

C. A Media Menu channel icon shall appear on every client copy of MediaController Browser software. When the teacher selects the menu channel bitmap, the encoder switches to the stream.

D. The automatically produced menu channel shall be the MediaMaster MM-1020 MenuChannel software and hardware product by ETR, or equal.

2.11 ADDRESSABLE MEDIA CONTROL MODULE (ACM) & MYCHANNEL

A. The ACM allows global control of multiple video playback source sites in an individual school, or as a district wide WAN Video-on-Demand system without adding or maintaining multiple servers. The ACM shall consist of, but not be limited to the following:

1. The ACM shall have eight (8) Infrared output ports for controlling video playback devices such as VCRs, DVDs, LDPs, CATV STBs, DirecTV receivers, etc.
2. The ACM shall control infrared players and receivers via infrared emitter cables. Emitter cables shall be 10’ long with 3.5mm mini jacks. Each emitter shall be affixed over each player’s or receiver’s IR receiver via self-adhesive tape, then covered with the included IR mask for additional protection and adhesion.
3. The ACM shall be locatable anywhere on the WAN/LAN. The ACM shall function as an Ethernet Network Interface Card (NIC) allowing local and remote control of infrared video playback sources. Each ACM shall have a unique IP address for identity on the network.
4. The communication protocol between the ACM and Video On Demand Server shall be TCP/IP.
5. The ACM shall have a standard 10BaseT connector for connectivity to the LAN/WAN. The 10BaseT connector shall have a Link status light and a Transmit Data light.
6. Each ACM shall have the inherent ability to learn IR control commands or accept downloaded command sets. Devices or systems that require a separate or master IR learner box or similar device are unacceptable.
7. The ACM shall have an RS-232 port which can be used for local control, local diagnostics, local IR learning, and local monitoring.
8. The ACM shall include graphical Windows based configuration and diagnostic utility software. Systems, which use character based configuration utilities, will be unacceptable.
9. The ACM microprocessor, real time clock and battery shall be self-contained on a 72 pin SIMM for quick and simple field servicing.

10. The ACM TCP/IP protocol stack shall support standard network diagnostic functions such as PING.
11. The ACM IP address shall be assigned from the MediaServer. Systems which use a dedicated device name, as an addressing scheme shall be unacceptable.

B. This project provides the School with nine 1080p clear QAM 60fps tuner/encoders for CATV distribution. A substantial portion of network bandwidth will be dedicated for IPTV and VOD requirements. But the School's CATV provider provides more channels than there are encoders and bandwidth to transport them. MediaMaster MyChannel shall automatically and dynamically tune channels to serve teacher requests for CATV and DirecTV channels on demand.

C. MyChannel is an essential MediaMaster software feature that integrates MM-1210 ACM Ethernet to infrared controllers to CATV IRDs and DirecTV receivers via MM-1202 IR Emitters. This integration maximizes access to multicasts by efficiently managing teacher requests and balancing them against available hardware and bandwidth.

D. All teachers may easily select channels via their Web based MediaController GUI. If the system is serving 9 unique and simultaneous CATV channel requests it will then display a There Are No Available Tuners At This Time, Please Try Again Later message. Once any channel is no longer being viewed MyChannel frees up that hardware to serve the next teacher requesting a different channel.

E. MyChannel can store thousands of broadcaster logos in a selectable menu in M/Administrator/Channels. This Integrator shall pre-load the full color bitmaps of every broadcaster logo available from Plymouth South High School’s CATV provider and DirecTV Goes to School. Channel lineups from all service providers are constantly changing. MyChannel shall allow the school to easily load new broadcaster logos as they change or as new ones are established.

F. MyChannel will allow the system administrator to add CATV IRDs, DirecTV receivers, Dish Network receivers, Free Over The Air Digital STBs, SD encoders, HD encoders; and provide management of these additional video on demand components without the purchase of additional software or licenses.

G. The District shall supply a 10MB data port, the communications subcontractor shall supply and install a CAT6A data cable and static IP address.

H. The IP addressable media control module shall be the MediaMaster MM-1210 ACM by ETR, or equal.

2.12 HD BLADE ENCODER SYSTEM

A. Provide a flexible, configurable, reliable, and fault tolerant multicast encoder system for 24 hours x 365 days per year operation.

B. The system shall be rack mounted in the top of the IPTV & VOD headend equipment cabinet. Encoder blades shall be hot swappable and slide into a 17 slot chassis with dual redundant hot swappable power supplies. All unused openings shall be covered with SB1 or SB2 blank plates.

C. Blades shall be available in MPEG-2 SD, H.264 SD, and H.264 HD with HDMI connectors and H.264 HD with HDMI & RGB connectors. The system shall support a mix of blade types without conflict. The system shall allow the System Administrator to easily reprogram IP addresses, Netmask, Gateway, Multicast Stream Address, Encode Bitrates, Audio Quality, Frame Rates.

D. All HD blades shall be 1080p licensed. They shall feature upgradeable resolution licensing which can be remotely upgraded by loading a license key.

E. Provide nine (9) high definition encoders. H.264 encoders for the CATV STBs (CATV STBs provided by Owner). HD encoders shall be the MediaMaster MM-1288H4 1 Channel H.264 HDMI Encoder Blade or equal. Provide each with a 1080p license key preloaded.

F. The 17 slot encoder chassis with hot swappable redundant power supplies shall be the MediaMaster MM-1287 17 Channel MPEG Encoder Chassis.

G. Provide two (2) high definition H.264 encoders with power supply for portable recording purposes anywhere in the school; MediaMaster MM-1288H4C HDMI & RGB Single Channel H.264 Encoder with MM-1282 chassis and power supply and 1080p license. Both are for the mini-head end DVD/VCR devices.

H. Provide three (3) high definition H.264 encoders with power supply and 1080p licenses; one for broadcasting from the TV Control Room, one connected to the video matrix switcher in the auditorium control booth for video camera presentation, and one connected to the small group seminar video matrix switcher to encode the teleconferencing camera streams. MediaMaster HD encoder MM-1288H4C HDMI & RGB single channel encoder with power supply or equal installed in MM-1282 chassis or equal.

2.13 MDF HEADEND

A. Provide 84” fully enclosed cabinets with locking rear door, removable side panels, rack mounted VOD content server, rack mounted VOD control server, 1 rack mounted bulletin board server, CATV receivers on shelves, Ethernet to IR controllers, blade encoder and chassis system, amplifiers, splitters, power strips with 10% spare receptacles, full time UPSs, and all miscellaneous components required for a complete IPTV VOD system. Assembly shall be designed to allow heat to rise without obstruction and not overheat sensitive components. Warmest components shall occupy the upper rack spaces. All unused spaces shall be filled with blank panels.

B. The entire MDF headend must be engineered, factory built, tested, certified, and crated by the manufacturer prior to shipment. Engineering schematics must be submitted for approval then again as closeout documentation.

C. Every component and the entire MDF headend assembly shall be fully compatible with the MediaMaster VOD and IPTV Web control software specified by this section.

2.14 MY CHANNEL ON DEMAND - 1080p HD SYSTEM FOR CATV

A. Communications subcontractor shall be the District’s liaison to coordinate free CATV service with a flat, unsloped, strong +25dB signal strength @ CH2 and +25 dB signal

strength @ CH70. Maintain, extend, modify, and connect the School's CATV system to serve the new IPTV & VOD headend. Provide shelves and mounting components in the headend cabinets, on the wall, and throughout the building as required. The IPTV & VOD headend is the preferred CATV demarcation location.

B. The local CATV service provider will supply the School a free lineup of educational channels in digital formats and various frequency ranges. Communications subcontractor will supply 9 integrated receiver/encoders to allow 9 unique and simultaneous on demand CATV multicast streams. Provide shelves and mounting components in the headend cabinets. System shall be modular to allow expansion. Communications subcontractor shall pay HD STB lease and setup fees to CATV provider for basic and enhanced basic service from start of construction until acceptance, then until the conclusion of warranty.

C. Provide MediaMaster MyChannel Ethernet Control & Management System for CATV HD tuners. System shall allow teachers to select 9 unique channels for simultaneous manual or prescheduled encoding via MediaRecorder software.

D. Provide MediaMaster MyChannel CATV on Demand software on the MediaMaster MM-3000-D MediaServer to allow teachers using MediaMaster MM-1150 MediaController to select channels on a first come first serve basis. The first nine teachers at any given moment that select a CATV channel will take control of the tuners, the tenth teacher will be asked to try again when resources are available. Regardless if receiver control is available or busy every teacher in the building may view any of these nine CATV channel streams.

E. Provide all work, materials, grounding, and manner of placement in strict accordance with requirements of latest edition of National Electrical Code.

F. Provide all materials listed as complying with available standards of Underwriter's laboratories or other similarly established standards and carry their label. Apply all materials in strict accordance with Underwriter's laboratories listing.

G. CATV streaming may be expanded at any time by adding receivers, shelves, splitters, cabling, encoders, etc. Systems that require additional licenses or software fees for this expansion are not acceptable.

H. System shall allow any or all channels to be enabled or disabled quickly and effortlessly. When channel(s) is disabled there shall be no way to circumvent the system. When channel is enabled it shall be available at every TV & projector via decoder/display controller, and every computer with MPEG Player.

I. Channels must be streamed via HD multicast encoders on the LAN/WAN. Bit rate shall be variable from 4 Mbps to 20Mbps. Streaming via the Web is not acceptable. Channel streams shall be viewable on computers with MPEG Players, and on projectors & TV with HD decoders.

J. System shall allow channels to be “pushed” & multicasted to any or all TVs & projectors manually via MediaAdministrator/Zone Page, or automatically via prescheduled Playlist. When pushed TVs & Projectors shall Power On, switch input, adjust volume, decode and display required channel.

K. The complete CATV on demand system and all peripherals shall be the MediaMaster MyChannel CATV on Demand System product as by ETR, or equal.

2.15 LOCAL ORIGINATION MULTICASTING

A. MMAdministrator/Zones shall allow broadcast personnel to quickly configure an All Page Zone or Specific Page Zones to receive broadcasts, by simply selecting TVs and projectors via checkboxes.

B. MediaController shall be used to view IPTV multicasts on PCs or MACs equipped with MPEG-2 players. Selecting the broadcast icon will trigger the player to open and decode the multicast stream.

C. Activation of a Video Page shall automatically disrupt and page all in progress IPTV viewing on PC devices, TV and projectors with tuner/decoders from current activities, deliver the broadcast, then restore the system to its original configuration following the Video Page.

D. Activation of a Video All-Page Broadcast shall initiate a Power On command to any TV or projector that is Powered Off, all video sources in use will Pause, and all TVs and projectors will tune to the School's local origination broadcast channel automatically.

E. Upon completion (deactivation) of the Video All-Page, all TVs and projectors will resume their previous status and sources will stay in pause mode until the teacher or student is ready to resume its use.

F. All local origination broadcast equipment shall include all cables and appurtenances required for a turn key system.

G. The video page zone configurator and TV/projector controller is part of the MediaMaster MM-1185 MM Administrator (specified previously).

H. The IPTV controller for PCs and MACs is part of the MediaMaster MediaController (specified previously).

2.16 INSTALLATION OF OWNER PROVIDED HIGH DEFINITION MPEG DECODERS/ NETWORK DISPLAY CONTROLLERS AND TVS AND PROCUREMENT AND INSTALLATION OF TVS

A. Provide and install HDMI and RS232 cabling (RS232 cable 9 conductor minimum) and terminations from STBs (STBs provided by the Owner, to be installed and re-programmed by subcontractor of this section) to the projectors and TVs as specified (TVs provided and installed in this section are specified below, plus installation of five Owner provided 42" TVs and wall mounts, listed below). Provide and install cat6a patch cords (black) from all STBs to data ports.

1. Install 93 Owner provided MM-1274 set top boxes at interactive projector locations. HDMI and audio cabling provided by 274000; RS232 terminations by communications subcontractor of this section.
2. Install 3 MM-1272 set top boxes provided by Owner at large format projector locations (Small Group Seminar, Auditorium Booth, Café). Provide all cabling required (RS232 and HDMI to projector in Café, HDMI cabling from set top box to local AV switcher and sound cable from set top box to local audio system input in Small Group Seminar and Auditorium Booth, and RS232 cabling to control system in Auditorium and Small Group Seminar).

3. Install 5 Owner provided 42” TVs and 5 Owner provided wall mounts, and 5 Owner provided MM-1272 set top boxes for these TVs (103G, 103F, 103E, 103C, 103B). Provide and install HDMI and RS232 cabling for these TVs.
4. Provide and install four 42” TVs with pole mounts in 271A and 4 Owner provided MM-1272 set top boxes. Provide and install RS232 and HDMI cabling to each TV.
5. Provide and install four 42” TVs with pole mounts in 147 and 4 Owner provided MM-1272 set top boxes. Provide and install RS232 and HDMI cabling to each TV.
6. Provide and install a 42” TV with wall mount in 100A and 1 Owner provided MM-1272 set top boxes. Provide and install RS232 and HDMI cabling to TV.
7. Provide and install a 42” TV with wall mount in 101A and 1 Owner provided MM-1272 set top boxes. Provide and install RS232 and HDMI cabling to TV.
8. Provide and install a 70” TV with wall mount in 101B and 1 Owner provided MM-1272 set top boxes. Provide and install RS232 and HDMI cabling to TV.
9. Provide and install a 70” TV with wall mount in 145D and 1 Owner provided MM-1272 set top boxes. Provide and install RS232 and HDMI cabling to TV.
10. Provide and install a 60” TV with wall mount in 169 and 1 Owner provided MM-1272 set top boxes. Provide and install RS232 and HDMI cabling to TV.
11. Install one Owner provided MM-1272 STB in TV control room. Provide and install HDMI cabling and audio cabling

B. All TVs provided shall be high definition LCD TVs and with advanced features that include but are not limited to: 1920x1080 pixel resolution, 50:000 dynamic contrast ratio, minimum 160 degree viewing, RGB/PC input, NTSC & Clear QAM tuner, 1080p HDMI/DVI interface with HDCP Digital Content Protection System, high definition (HD) component video inputs, front firing speakers, built-in audio amplifiers, side mounted AV input panel, automatic signal enhancement, firmware modified for front panel lockout, 60,000 hour life expectancy, three year warranty, Energy Star Compliant, MediaMaster Network Certified for RS232 control and status. TVs must have a minimum of 3 HDMI inputs and RS232 control port.

C. Provide and install tilting brackets listed above with all mounting hardware for wall and pole mounted TVs. Brackets shall feature security hardware to prevent TV removal without the use of proprietary tools. Supply 2 security hardware tools to the school at the close of the project. Provide and install as appropriate for size of TV.

D. The MediaServer shall lock out all front panel controls on TVs installed in public spaces and classrooms to avoid building occupants selecting channels or media other than what the Administration wants viewed. Systems and components without this lockout feature are not acceptable.

E. TVs in public spaces shall not allow local control, they shall strictly perform as directed by Media Playlist to achieve automated broadcasting results such as Bulletin Board messaging.

2.17 MEDIA DELIVERY NETWORK

A. If the Communications Subcontractor’s IPTV system cannot function on the School’s network without modification, (except for network electronics configuration) then the Communications Subcontractor shall provide an independent communication and

control network for the building. The Communications Subcontractor installation shall be “turn key” in every respect. The communication and control network must be submitted and approved.

B. The system shall allow local origination video/audio multicasting from every room.

C. All video on demand equipment shall be located in rack mounted equipment cabinets. Equipment cabinets shall be easily accessible for routine maintenance as per NEC. Provide custom-made rack panels for all video components and blank panels for all unused rack spaces. Amplifiers, encoders, processors, and other components that generate heat shall be mounted high in the cabinets to reduce radiation to heat sensitive components and media. Provide ventilation as per Manufacturers requirements.

D. The Communications Subcontractor shall provide all MediaServers, software, menu channels, video playback sources, scan converters, racks, shelves, cables, processors, combiners, amplifiers, fiber converters, media converters, and concentrators to provide a “turn key” IPTV video on demand system installation.

2.18 RG CABLING, SEE DRAWINGS

A. RG11, 75 Ohm Solid 14AWG Video Distribution Riser Cable, See T2.6 and T2.7

1. The coaxial cable must be black. Colored tape may not be used to re-identify jacket color.
2. The cable shall be composed of a solid 14 AWG bare copper conductor insulated with gas injected foam high density polyethylene, surrounded by a Polyethylene jacket. Cable shall be RG/11/u
3. Cable shall have a bare copper braid shield (97% coverage).
4. The cables shall meet or exceed the following standards:
   a. EU CE Mark
   b. National Electric Code- CATV or CM Rating
   c. UL-1581 Flame Test Rating
   d. Cable manufacturer must be ISO-9002 Certified
5. Cable shall meet the following performance specifications:
   a. Conductor diameter: 0.064”
   b. Impedance: 75 Ohms
   c. Attenuation, Max:

1 MHZ- 0.2 DB/100’	10MHZ- 0.4 DB/100’
50MHZ- 0.9 DB/100’	100MHZ- 1.3 DB/100’
200MHZ- 1.9 DB/100’	400MHZ- 2.9 DB/100’
700MHZ- 4.1 DB/100’	900MHZ- 4.8 DB/100’
1000MHZ- 5.2 DB/100’	

   d. Structural Return Loss- 5-450MHZ, 23DB
   e. Maximum Operating Voltage- 600v RMS

f. Normal Conductor DC Resistance @ 20deg C- 2.6 Ohms / 1000'

g. Normal Shield DC Resistance @ 20deg C- 1.1 Ohms / 1000'

6. Provide as shown on T2.6 from MDF to TV Head End and as shown on T2.7.

7. The cable is Belden wire and cable, model 8213 or equal.

B. RG6 CABLING, SEE DRAWING T2.7

1. The coaxial cable be black. Colored tape may not be used to re-identify jacket color.

2. The cable shall be composed of a solid 18-gauge bare copper covered steel conductor insulated with gas injected foam polyethylene, surrounded by a Polyvinyl chloride jacket. Cable shall be RG/6.

3. Cable shall have a bonded aluminum foil polyester tape aluminum shield plus aluminum braid shield with 90% shield coverage plus bonded aluminum foil shield with shorting fold.

4. The cables shall meet or exceed the following standards:

a. Underwriters Laboratory- CATV or CM Rating

b. National Electric Code- CATV or CM Rating

c. UL-1581 Flame Test Rating

d. Cable manufacturer must be ISO-9002 Certified

5. Cable shall meet the following performance specifications:

a. Impedance- 75 +/- 3 Ohms

b. Attenuations Max:

5 MHZ- 0.67 DB/100'	55MHZ- 1.60 DB/100'
211MHZ- 2.87 DB/100'	270MHZ- 3.24 DB/100'
300MHZ- 3.43 DB/100'	350MHZ- 3.72 DB/100'
400MHZ- 4.00 DB/100'	450MHZ- 4.26 DB/100'
550MHZ- 4.71 DB/100'	750MHZ- 5.59 DB/100'
870MHZ- 6.00 DB/100'	1000MHZ- 6.54 DB/100'

c. Structural Return Loss- 5-1000MHZ, 20DB Min

d. Maximum Operating Voltage- 350v RMS

e. Normal Conductor DC Resistance @ 20deg C- 28.00 Ohms / 1000'

f. Normal Shield DC Resistance @ 20deg C- 3.7 Ohms / 1000'

6. The recommended cable is Belden Wire and Cable, Series 6 CATV, Model #1621A

2.19 LIBRARY ROOM MINI HEADEND 200A

A. Provide one (1) MM-1210 Ethernet to infrared controller, 2 MM-1211T or equal VCR/DVD UNITS on shelves, 2 MM-1202 IR emitters, amplifiers, splitters, power strips with 10% spare receptacles, 1 full-time UPS, 2 H.264 HD encoders, AV cables, data cables, and all miscellaneous components required for a complete mini IPTV on Demand system. Assembly shall be designed to allow heat to rise without obstruction and not overheat sensitive components. Warmest components shall occupy the upper

shelves. Provide vents in cabinet if not already provided. Provide fans as necessary to dissipate heat. Rack shall be mounted to the top of the cabinet behind the circulation desk in the Library.

B. The entire mini-headend must be engineered, factory built, tested, and certified, by the manufacturer prior to shipment. Engineering schematics must be submitted for approval then again as closeout documentation.

C. Every component and the entire mini-headend assembly shall be fully compatible with the MediaMaster VOD and IPTV Web control software specified by this section.

2.20 FM TRANSMITTERS – PE ALTERNATIVE

A. Provide 4 stereo FM transmitters in PE Alternative for 4 ceiling mounted LCD TVs

1. FM band must cover 88.1 to 107.9 in .1mhz steps.
2. Compact design with digital display.
3. Comply with FCC part 15 (FCC ID: XOAWH-FMT).
4. Phase lock loop (pll) required.
5. Automatic gain control.
6. Must be able to be powered by USB, include cable to connect USB for power to IPTV decoder box at each TV.
7. Include RCA cabling to connect TV audio out (or IPTV STB) to FM transmitter.
8. Minimum 100’ range

Provide four (4) Whole House FM Transmitter 2.0 or equal.

2.21 FACTORY BUILT AND CERTIFIED CENTRAL HEADEND

A. The Central Headend shall be located in the MDF and shall be capable of serving additional school buildings.

B. The Manufacturer shall request a VLAN and network setting specifically for the Central VOD, IPTV, and AV Management System. These network settings shall be placed in a spreadsheet listing Architectural Room Assignment (from Plans), Actual Room #, Projector/TV Type, Manufacturer/Model #, Wire Closet, Patch Panel, Switch Port, etc. It shall also list the IP, Netmask, Gateway, Multicast, for both the TV/Projector and the MM-1271/5 Decoder/Display Controller. This spreadsheet shall be included in the Component Submittal for Approval.

C. Prior to assembly the Manufacturer shall engineer the Central Headend as a CAD drawing. An accurate and detailed Cabinet Drawing and Schematic shall be submitted for approval. These drawings must detail every component, connector, cable, component label, mounting hardware, screws, and network assignment label. Single line drawings with title boxes for components are not acceptable.

D. Provide one 37RU enclosed equipment cabinet with removable side panels and locking rear door. All components shall be rack rail or shelve mounted. Receivers and STB

shall be vertically mounted for heat dissipation and captivated to mount. Warmest components shall be located on top, coolest components on bottom.

E. Provide a full time, on-line UPS system providing sine wave correction, voltage regulation, spike suppression, and a minimum of 1,500 watts of backup power. Standby UPS systems are not acceptable. The UPS shall provide full time protection for the MediaServer, Digital Video Server, Bulletin Board PC, CATV Receivers at a minimum. UPS must have 120v 30 amp twist lock plug for connection to rack power outlet.

F. Provide 19” rack mounted HD monitor with XGA cables installed for the MM-3000-D MediaMaster VOD Server and the MM-8100PV Bulletin Board Server, and HDMI installed cables for CATV STBs. Include AV switcher to manually select these inputs.

G. Provide surge protected full length power strips with 10% spare outlets.

H. Every component shall be factory installed by the Manufacturer and pre-programmed with Owner provided IP Addresses, Netmasks, Gateways, Multicast Addresses, and Remote Access Assignments.

I. The Manufacturer shall label every component, test and certify the entire headend, crate assembly, ship on air ride moving truck, deliver directly to MDF room, install final cables and connections, test system with Owner present, train Owner how to push VLC Player and automate MediaMaster Launch Script to all computers, train Owner's Trainers.

2.22 MEDIAMASTER LIVE PUBLIC MEDIA PORTAL

A. The Public Media Portal shall consist of, but not be limited to the following:

1. Provide a Public Media Portal that allows Users to make on-demand and live video that resides in the VOD & IPTV system available via the Owner's public Web site. Selected video titles, live, and Bulletin Board streams within the system shall easily be shared within the Media Portal interface on the school's Web site. Features shall include search, content descriptions and social media integration. Media Portal should be able to be embedded within a client's Web site so it resides within their Web site pages.

2. The Internet Portal Server shall be located in the MDF. It shall be rack mounted into the media cabinet to keep it clean and prevent bumping and jarring. It shall feature forced-air cooling. Cooling air shall be drawn through a front cleanable filter and exhausted out of the rear of the case. The rack mount case shall be constructed to provide adequate airflow over all components.

3. System proposed must include hardware, software and end-user interface features as necessary to automatically transcode uploaded video files into a standardized H.264 format without additional user intervention. Must support transcoding of industry-standard videos that are uploaded including Windows Media, AVI, OGG, MPEG1, MPEG2, MPEG4 (.m4v, mp4, h.264) and QuickTime (mov).

4. Ability to modify the default resolution, bit-rate and bandwidth setting for the transcoding.

5. After transcoding the video files must be moved automatically to the Streaming VOD Server for storage and the database must be updated so the new H.264 format video is accessible for on-demand viewing through the user interface without having to upload again.

6. Must include hot-swap drive bay, minimum of a 146GB hard drive with hot-plug caddy.

7. Encoder must support encoding in a quality-level from 128kb/s up to 7Mb/s and up to 720x480 resolution and 30fps bit rate.

8. Encoder must support encoding and live streaming of 12 unique video feeds. Each of the 12 channels must simultaneously be able to stream at a minimum of 2Mb/s, 720x480 30fps without dropping a frame in either Windows Media or H.264 format.

9. Must support delivery of multicast and up to 40 on-demand unicast streams for every channel as well as support redirection to the central streaming server for an increased number of unicast viewers of those streams over the WAN.

10. Must be controllable through the system's web-interface including start, stop, preview and scheduling of encoding events.

11. Must support recording of the encoding channels directly into the digital library and centralized streaming server storage making them available on-demand after the event is complete.

12. Adaptive bitrate technology polls the client's browser and bandwidth, then automatically optimizes the stream bitrate and resolution to the player's capability.

13. Public Media Portal shall be licensed to serve Plymouth South and North High Schools.

2.23 BUILDING CONFIGURATION AND EQUIPMENT

A. As specified above, provide, install, configure:

1. (1) Media Server MM-3000
2. (1) Digital Video Server, 25TB min
3. (400) User Per Site License for MediaServer, Digital Video Server, MediaController, MediaScheduler, MM Administrator, and Playlist.
4. (1) Networked Video Recorder
5. (1) Mini-HeadEnd with 2 VCR/DVD players and HD encoders (HD encoders listed below)
6. (2) Uninterruptible Power Supplies
7. (1) Menu Channel
8. (3) Addressable Control Modules with 11 emitters
9. (1) Bulletin Board with 6 PrestoVideo HD H.264 Multicast Bulletin Board streams
10. (9) HD H.264 HDMI Multicast Blade Encoders for CATV STBs

11. (1) 17 slot Encoder Blade Chassis & PSs
12. (5) HD H.264 HDMI & RGB encoders in chassis (auditorium control booth, TV studio, one in small group seminar, 2 in mini-headend)
13. (5) 2 slot encoder blade chassis & Power Supplies
14. (1) CATV on Demand System
15. (9) MyChannel for CATV on demand system
16. (9) 1080p HD CATV Set Top Box Integration.
17. Integrate all 5 Panic Switches and Automatic Lockdown function messaging of VOD System Software.
18. Communications Subcontractor's shall coordinate with 27 40 00 Communications subcontractor to install control cabling and connections, if required, for projector RS232 control via the T1 and V faceplates in all rooms with those symbols.
19. Communications Subcontractor's shall install and cable all Owner provided CATV service provider's IRDs (9) for integration into the system.
20. Two (2) 70" TV. Provide tilting wall bracket2.
21. One (1) 60" TV. Provide tilting wall bracket2.
22. Ten (10) 42" TVs. Provide tilting wall brackets (2) and pole mounts (8).
23. Fabricated Head end and mini head-end racks with elevations.
24. (2) unified DVD/VCR players for mini-head end.
27. Provide all software for the IPTV system needed to view content to the Owner in February of the year the school is scheduled to be completed for school PC imaging to commence.
28. Coordinate B1 locations/connections for TV with 274000 communications subcontractor. B1 to B1 faceplates and cabling to be provided and installed by 274000. Provide and install HDMI from wall B1 plate to TV. IPTV system shall be programmed to provide all B1 inputs as a selection on the GUI for the local device (projector or TV).
29. Install and reprogram all Owner provided set top boxes (Qty 115). Provide and install black Cat6A network patch cable for all STBs and HDMI cabling to local TVs at all locations. Provide and install all cabling at Auditorium booth projector, café projector and small group seminar projector
30. Install 5 Owner provided TVs and mounts.
31. Provide and install four (4) FM transmitters in PE Alternative for the TVs.
32. Public Media portal (MediaMaster Live) with 2 building licenses
33. All cabling required for a complete and functional installation.
34. Any other equipment, licenses or devices required or specified not specifically listed above.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Notify local cable service provider regarding project requirements and schedule. Ensure that cable service provider completes their portion of Work in timely manner to not interfere with project schedule or other trades. A flat signal of +25dB @ CH2 through +25dB @ CH70 shall be requested.

B. All cables originating from outside building grounded at nearest point of entry.

C. Extend or relocate incoming CATV service to connect to head end rack equipment. Provide appropriate multisswitches, taps and splitters.

D. Seal all penetrations per electrical wiring methods specified for this Project.

E. All vertical cable runs installed in concealed conduit/raceways. Surface mount raceway allowed only where specifically shown on drawings or where approved by architect. Exposed or unprotected cabling is not allowed.

F. Make any bends in cable in 90-degree increments while maintaining less than minimum cable bend radius. All cable routes parallel or perpendicular to building lines and installed to prevent any cable from crossing or wrapping around bundle. Service loops or excessive slack not allowed. Provide for neat tangle-free cable route.

G. Equipment cabinet(s) anchored to wall or floor utilizing an approved method.

H. All head-end equipment securely installed within equipment cabinet(s) by screws, bolts, and nuts or by method approved by manufacturer. All holes intended for equipment mounting used for securing equipment to rack. Provide all exposed hardware in same color and type, preferably matching cabinet finish (i.e., black cabinet-black rack screws).

I. All cabling entering video equipment cabinet(s) installed in conduit or raceway. All cabling within cabinet neatly bundled and secured with tie wraps to cabinet. Avoid cable strain on connectors/terminations. Do not use point of connection to serve as support for cable bundle.

J. All rack ground bars grounded to equipment ground bus, in nearest power panel, utilizing 6 AWG THHN. Ground wire concealed in metallic conduit containing no other power conductors. Ground rack-to-rack ground bar by NEC approved method.

K. After installation of wiring and equipment has been completed, test all cabling to ensure continuity, freedom from grounds (except "made" grounds and those required for protection), and insulation resistance, in accordance with "underwriter's requirements and electrical regulations. Furnish and use suitable instruments such as ammeters, voltmeters and ohmmeters.

L. Prior to final acceptance, provide accurate documentation listing all equipment installed under this Section, including following information: equipment description, equipment part number, equipment serial number, manufacturer’s warranty period, and location of equipment. Any information found to be inaccurate during three-year warranty period requires Communications Subcontractor to physically re-verify all equipment information at no additional cost to Owner. Complete re-verifications within 1 week after notification of any discrepancy. Submit copy of all documentation to Technology Director.

M. For every piece of equipment installed under this Section, deliver, in one delivery, associated manufacturer’s manuals in addition to maintenance manuals specified in

other Sections of Project Manual. Provide Owner 3 copies of all material, and architect one copy.

N. Provide installation and start up of all systems under direct supervision of local agency regularly engaged on installation, repair, and maintenance of such systems.

3.2 FIELD QUALITY CONTROL

A. Testing:

1. Test every television outlet for signal level, clear picture and remote origination/control (as applicable).
2. Test all head-end equipment for proper frequency, audio/video carrier levels, and RF level outputs. Adjust all levels per manufacturer's recommendations.
3. Perform tests to all systems under direct supervision of manufacturer's representatives or accredited agencies for all specified equipment and services.
4. Submit all test results in tabular format with reference to or backed up by equipment/riser diagram that accurately represents installed system.
5. Submit written test report from authorized representative of equipment manufacturer stating that system has been tested and is in working order prior to final inspection.
6. Architect and/or Owner's representative reserves right to observe testing.

3.3 DEMONSTRATION

A. Owner's Training: Provide minimum 24 hours of training for Owner's personnel used at Owner's sole discretion and scheduled by Owner to fit Owner's needs.

1. Training scheduled by Owner in blocks of 4-8 hours.
2. Include all per diem and travel costs in cost of training.
3. Include following minimum content in training:

   a. General systems overview describing sub-systems and their relationships with each other.
   b. Specifics on sub-systems and how to maintain them to ensure reliable operations.
   c. Operation of equipment to perform intended tasks, including (but not limited to) remote origination, camera operation, television operation, cable patching, equipment replacement and so forth.
   d. Provide written documentation for all training attendees to supplement training (i.e., diagrams, training outlines/highlights.)

4. All training materials shall be provided to the Owner in digital format, and all training shall be video recorded by the communications subcontractor and provided to the Owner on DVDs.

END OF SECTION

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SECTION 28 13 00

ACCESS CONTROL

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of a Contract, including conditions of the Contract and Division 1 of the Specifications, shall apply to the Work in this Section

B. Drawings and general provisions of the Contract, including all portions of the Project Manual are hereby made a part of this Section. Refer to paragraph titled “Quality Assurance” in this section and to Division 1 for requirements for Communications Subcontractors. Throughout this and related Sections, “Subcontractor” shall not be limited to the singular and masculine and shall refer to one, or more than one, Communications Subcontractor. The Terms “Communications Subcontractor” and “Communications System Integrator “ shall be used interchangeably and shall be understood to represent the communications subcontractor responsible for the furnishing, configuring, testing, programming, warranting and ensuring all work is performed in accordance with manufacturer’s requirements and recommendations for the work identified in this SECTION.

C. Any qualifications or certificates required in this specification may be requested by the Architect as part of the post-bid qualifications review. Such review shall commence subsequent to the bid submission, as none of this information is required as part of the bid submission. In the event that the Architect requests qualification or certification documentation such documentation shall be provided within 3 business days.

1.2 SUMMARY

A. Access Control System, by Hirsh Electronics, including, but not limited to, the following:
1. Server and SDK license shall be provided **by owner** and made available to the subcontractor of this section for programming. All South credentials will already be existing on this version 3.5 Velocity server.
2. Intrusion detection devices
3. Access control devices, related hardware, wiring and panels. All panel models shall be M#N2, which include SNIB2 boards such that the panels will use TCP/IP communications.
4. Access control, relay control, and alarm monitoring controllers
5. Door, overhead door and roof hatch contacts, DPDT, installation, wiring, integration. Provide and install a 6 inch by 6 inch back box with cover above every doorway with door contacts for splicing, wiring and MELM installation. Provide MELM or MELM2 as appropriate at every doorway with contacts.
6. Request to Exit devices, wiring, installation, integration. REX devices shall be wired to allow the owner the option to ignore a rex device and send an alert whenever the portal is opened. Rex devices shall only shunt door contacts, NOT unlock doors. All doors with door contacts require rex devices, whether the door has access control devices or not. Provide all pathways and back boxes required for REX installations.
7. Local Door Sirens, wiring, installation and integration where shown on the drawings (SI

symbol)

8. Key switches, if shown on the drawings, to include wiring and installation and inputs to the access control system
9. Guarded/shielded panic button devices in locations shown as PB on the drawings to initiate immediate lock down of the access control system as defined by the Owner.
10. Provide inputs to connect motion detector outputs in all stair wells, vestibules, hallways, and where indicated on the drawings to both the intrusion and access control systems for alerting staff during after-hours of normal occupancy. Provide any licenses and hardware required to perform this function. Connect access control inputs to motion devices or intrusion outputs for each motion detector. Motion detectors provided and installed by 281600.
11. Any other hardware/software required to ensure a fully functional access control security system not specifically listed in this specification.
12. Provide devices and equipment in MDF that will utilize a pair or a single multimode or single-mode fiber or other network communication devices will allow the security system in the school to be fully integrated into the town wide access control system. The server for the South school will not reside in the south school. Coordinate with Owner. Fiber from the town to the MDF will be provided by Owner.
13. The work of this section is shown on Technology Drawings designated by a T.
14. No corridors or spaces are air plenums. No cabling needs to be plenum rated.
15. All equipment and materials used shall be standard components, regularly manufactured, and regularly utilized in the manufacturer's system.
16. Provide in addition to all modules/blades required for a fully functional system in the MDF and IDFs 8 spare alarm inputs for access control and 8 spare alarm outputs from access control in every IDF that contains Hirsch panels, and in the MDF.
17. Provide and install in every IDF and the MDF network reportable temperature sensors with probes centrally located in the room with patch cords to the local switch.
18. Provide licenses for integration of CCTV IP cameras into the access control system if required by Hirsch. Provide all ASCI strings, software and hardware triggers, devices and wiring if required to allow these cameras to be called up on specific alerts (invalid/denied card read, forced door alarm, door ajar, motion triggers (stairs, vestibules, hallways), hardwired panic buttons and wireless panic button triggers). Coordinate alerts and triggers required with the Owner. Triggers shall be sent to the Avigilon Gateway server. Coordinate with 282300 subcontractor. At a minimum, all door openings and card reads shall be associated with the interior and exterior camera with a view of the doorway. Motions shall be associated with the camera with a view of the area. Names of all software triggers shall be coordinated with 282300 subcontractor. Minimum number of trigger programming required for camera call ups of forced inside and outside door alarms, motions and panics: 180.
19. Provide all integration required in coordination with elevator contractor and 27 10 00 to install a card reader at the elevators where shown on the drawings. Provide and install in every elevator mechanical room an M8N2. Connect to network. Capture circuit shall be included to enable parking of the elevators if desired by the owner during lockdowns. Access control programming of the elevators shall allow elevator buttons to be operational only upon a valid card read or key override.
20. Provide and install all patch cords to network switches for access control devices.
21. Provide and install software maps and all programming for interactive event reporting and operation of devices in access control. Maps shall include portals, keypads, card readers, door contacts and motions.
22. All access control panels shall be hard wired to the power circuit provided at the plywood back boards in the MDF and in each IDF. All panels shall contain a battery

backup and be the new model M#N2 which include an SNIB2 board for network connectivity and shall have the panel configuration with inputs/outputs/card reader doors assigned printed and affixed to the inside of the door.

23. 282300 subcontractor shall cable wireless panic button receiver relay outputs (Qty 14) provided and installed in 282300 section to a local Hirsch panel. 281300 subcontractor shall program Hirsch inputs for these panic devices as per owner direction. Provide and install relay inputs in the nearest Hirsch panel locations to for these devices. Coordinate cable required and locations of receivers with 282300 subcontractor. Install and configure in Hirsch system these panic button inputs. 282300 subcontractor shall leave cable coiled 15' above panels for final terminations in Hirsch panels by subcontractor of this section. Test in coordination with 282300 subcontractor all lockdown initiations from all panic devices, from all sections of work (281300 panic buttons, 282300 wireless panic buttons, and intrusion detection integrations and central station reporting for all panic button inputs).

24. Provide and install a relay output, programmed to close during a lockdown signal, wired to the fire alarm main control panel. Leave coiled at fire alarm control panel 15'. Subcontractor responsible for the fire alarm system shall make final terminations to fire alarm control panel. Intent is for lockdown signal in access control to close relay thereby triggering fire alarm control panel to drop doors off mag hold opens. Coordinate testing of intent with subcontractor responsible for fire alarm system. The relay closure in access control to the fire alarm panel shall be programmed to be closed for 10-20 seconds. The fire alarm panel shall be programmed such that this is a silent signal, without the fire alarm panel needing to acknowledge the signal or have it silenced each occurrence.

25. Two Hirsch client workstations, one in security office at main entrance, one in SRO office. (Intel i7 quad core 3.4ghz with 8mb cache, 8GB ddr3 sdram (1333mhz), 250gb 6.0gb/s SATA HD, 16x DVD+/- RW drive, mouse, keyboard, two (2) 20 inch monitors, 1gb video card with dual video outputs, sound card, speakers, 1 serial port, 1 Ethernet RJ45 port.

26. Ensure the Hirsch server and components are on the same subnet as the Avigilon servers. Coordinate with Owner and 282300 subcontractor.

27. Provide and install all patch cords to connect UPS devices, panels and other networked equipment to the network.

28. All electrified door hardware specified shall be controlled by access control, and programmed as per owner directions. See related work section for door hardware section, and drawings A7.11 and A7.12

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. All Sections of Division 27 and 28

B. SECTION 01 23 00 - ALTERNATES

C. The following related work or material shall be provided under the designated trades and

under the listed SECTION:

1. SECTION 26 00 00- ELECTRICAL All electrical work related to items in this Section.
   a. Coordinate with the electrical subcontractor to hardwire power to each panel from the emergency generator circuit in each IDF and the MDF room at the plywood back boards. Panels shall not be plugged into the wall outlets.
2. DIVISION 8 – Door Hardware
3. SECTION 14 – Elevators
   a. Coordinate work with elevator subcontractor to provide card readers and elevator car control outside every elevator door on every floor.
4. Drawing A7.11 and A7.12

1.4 REFERENCES

A NFPA 70 - National Electrical Code.

1. UL294 - Standard for Access Control Systems.

2. NFPA 72 - National Fire Alarm Code.

3. NFPA 101 - Life Safety Code.

1.5 REGULATORY REQUIREMENTS

A System shall be UL-Listed.

B. Intrusion system shall meet UL-610 Central Station Alarm System

1.6 SYSTEM DESCRIPTION

A. Proprietary specification. The awarding authority has voted the Hirsch Velocity Security Management System and related components as a proprietary product for this section to maintain compatibility with existing District infrastructure. The Hirsch Electronics "VELOCITY" Version 3.5 Security Management System shall be a modular and network capable access control and intrusion detection system. The Security Management System shall have the ability of handling facilities with multiple remote sites (3.5 version), controlled access with various reader technologies supported simultaneously, alarm monitoring with text and graphics based annunciation, Photo Call-Up, DVR/NVR and CCTV switcher control that allows for easy expansion or modification of readers, inputs, and outputs. The Hirsch Velocity Server and software shall be provided by the Owner.

B. Acceptable Substitutions: The product(s) specified above have been determined to be in the public interest based on sound reasoning and voted as proprietary by the Owner. Under provisions of Massachusetts General Laws, Chapter 30, Section 39M(b) and Chapter 149, other equal products not named herein, may be considered for acceptance as an equal by the Architect and Owner upon submission of complete product information as described in Section 01 25 13 - Product Substitution Procedures. Further additional information may be requested by the Owner or Architect for determination that the proposed product substitution is fully equal to the specified product(s). There is no guarantee that proposed substitutions will be approved, and the Communications Subcontractor shall not to order any materials until approval(s) are received in writing.

1. Requesting substitutions shall be at the Communications Subcontractor's own risk, with

regard to uncompensated delays of the Project. Time will be required for sufficient review and additional requests for information by the Architect and Owner. Delays which result from substitution reviews and resubmissions are not grounds for additional time or cost change orders, and will not be considered by the Awarding Authority.

C. The system shall support both manual and automatic responses to alarms entering the system. Each alarm shall be capable of initiating a number of different actions, such as camera switching, activation of remote devices, email of alarm/event, text page of alarm/event, and door control.

D. Access control functions shall include: validation based on time of day, day of week, holiday scheduling, automatic or manual retrieval of cardholder photographs, and access validation based on positive verification of card, card/PIN, and PIN.

E. The VELOCITY System shall interface to the CCTV system through an Avigilon alarm software gateway interface with Avigilon VMS. The CCTV system shall be programmed to respond to the alarm input, switching the appropriate camera(s) to the appropriate monitor/s and/or recording devices. All control of camera selection, position, zoom, focus, iris and pre-position shall be controlled by the CCTV system's keyboard/joystick controls. Advanced switcher programming shall be performed through the switcher and associated keyboard or software programming interface.

F. The VELOCITY System shall interface to the NVR system through an Avigilon alarm software gateway interface. This interface shall be loaded on the Velocity Server. The NVR system shall be programmed to respond to the alarm inputs through Velocity's Triggers/Actions Manager if required. In response to an alarm, the NVR shall record video as programmed, including: Pre-Alarm, Alarm Duration, Post Alarm, and Frames per second as defined for that camera. All control of position, zoom, focus, and iris shall be controlled by the NVR system's keyboard/joystick controls. Initial NVR setup and Advanced programming shall be performed through the NVR's configuration software programming interface. Provide and install the Avigilon alarm software gateway on the server and provide all Hirsch alarm programming in coordination with the 282300 subcontractor.

G. Utilizing assigned passwords, it shall be possible to define the levels of system operation for each individual Operator. Operator Actions range from basic monitoring to full control of the system databases.

H. The system programming shall be user-friendly Windows environment (use conventional "Title Bar", "Menu Bar", "Tool Bar" and "Status Bar") and allow mouse control of key functions. The programming shall be MENU driven and include on-line "Documentation", "Help" or "Tutorial" information. The software shall utilize combo boxes for previously entered system-required data where applicable.

I. System shall provide supervised alarm point monitoring. Upon recognition of an alarm, the system shall be capable of displaying alarm information in text format in a dedicated Alarm Viewer, real-time status in a Status Viewer, on a graphic floor plan, initiate alarm recording on an NVR, switching CCTV cameras, email an alarm notification to one or more people, and send a text page to a cell phone (set up as an email to the cell number @ the cell phone providers domain) that are associated with the alarm point. The system shall be capable of arming or disarming alarm points both manually and automatically, by time of day, and day of week.

J. The method of communication from remote locations to the central components shall be transparent to the user.

K. After installation, the Owner shall be able to perform hardware configuration changes as desired without the services of the manufacturer.

L. Equipment repair shall be able to be accomplished on site, by module replacement, utilizing spare components.

M. All controller components shall utilize "Distributed-Processing" concepts. The distributed processing shall include the ability to down-load operating parameters to any field panel, thus allowing the field panel to provide full operating functions independent of any other system component.

N. The system shall be capable of utilizing the existing LAN / WAN connecting the buildings or a dedicated security Ethernet network for Hirsch DIGI*TRAC Controller and Velocity Client communications. Use the Hirsch SNIB2 communications interface in each controller to communicate to the controllers via 10/100 Mbps, 128 bit AES encrypted Ethernet.

O. The Controllers shall utilize Version 7.4 or later Flash downloadable CCM (Command and Control Modules) firmware.

1.7 SUBMITTALS

A. Architect may require submittal submission within 45 days of bid award. Submit the following under provisions of Section 01 33 00- SUBMITTAL PROCEDURES with tabulated and indexed pages. Show reference to specification section in index. Any submittals received non-tabulated or indexed shall be returned without action.

B. Manufacturer's Data:
   1. Submit :
      a. Product Data Sheets.
      b. Installation Instructions.
   2. Manufacturer Certificate and Certified Training Certificates of communications contractors who will be providing, programming and warranting the equipment.

C. Shop Drawings:
   1. Submit three (3) digital copies in AutoCAD 2010 or later on a CD of shop drawings, including:
      a. Layout of equipment on supplied AutoCAD drawings, include labeled wiring risers showing all equipment.
      b. Rack elevation drawings.
      c. Field Controller equipment location wall layouts, including size requirements.
      d. Detailed wiring diagrams of Field Controllers, Door integration details, and head-end devices, camera locations, IDF and MDF closets.

D. Closeout Submittals:

   1. As-Built Drawings: Update Shop Drawings to create final As-Built Drawings. Submit 3 copies digitally in AutoCAD 2010 or later format on a CD.

   2. Operation Data: Include three (3) copies of the software Administrator and Operator Manuals.

3. Maintenance Data: Include three (3) copies: maintenance and repair procedures.

4. Digital copies of all training materials and DVD videos of all training provided on CD and DVDs.

5. Estimated costs for maintenance and software assurance for the three systems on a yearly basis. List each system independently (access control, intrusion, video surveillance). Cost shall include 2 yearly visits for preventative maintenance.

6. Submit costs for repairs and service not covered under warranty (ie: owner requested changes, acts of God, vandalism, misuse).

7. Warranty certificate with contact numbers with appropriate start and stop dates

8. PDF of product data and O&M manuals shall contain bookmarks for every section and item submitted.

1.8 QUALITY ASSURANCE

A. Manufacturers: Manufacturer shall be a single-source manufacturer for each of the system components, that specializes in access control systems each with a minimum of 5 years in the industry.

B. Communication subcontractor: Company specializing in intrusion detection, video surveillance and access control systems with a minimum of three years experience on systems of similar size and scope. Communications subcontractors working on project must be certified by the manufacturers on the hardware and software used for this project.

C. Propriety specification. The awarding authority has voted the Hirsch Velocity Security Management System and related components as a propriety product for this section to maintain compatibility with existing District infrastructure. Communications subcontractors must be certified by Hirsch to provide, install, configure, test and warrant the Hirsch Velocity system.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Owner will provide, on-site, a secure, dry, locked storage area for all equipment delivered under this scope of work.

B. Store products in manufacturer's unopened packaging until ready for installation.

C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.10 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.11 WARRANTY AND SERVICE AGREEMENT

A. All equipment, materials, and labor shall be guaranteed for a period of 36 months from the

date of final acceptance by the Owner. Warranty shall begin at this time, not the date of substantial completion. Systems must be fully operational, and accepted by the owner after training before the warranty is to begin.

B. The manufacturer or communications subcontractor shall repair or replace malfunctioning products at no expense to the Owner, except failures caused by damage or unreasonable use.

C. Communications subcontractor shall maintain regular service facilities and provide a qualified technician familiar with the work at the site within 24 hours of receipt of a notice of malfunction, excluding weekends and holidays.

1. Provide material, devices, equipment, and personnel necessary for repairs.

D. Provide accepted temporary, alternate equipment, if required by the Owner, complete and operational within 48 hours after notification of malfunction, at no additional cost during the first year of warranty.

E. Communications subcontractor shall conduct warranty repairs and service at the project site unless prohibited by manufacturer's warranty. If the latter, communications subcontractor shall provide substitute systems, equipment, and devices acceptable to the Owner for the duration of the off-site repairs. Replace items out of service more than 10 days with new equipment during the warranty period.

F. Communications subcontractor shall transport warranty equipment, substitute systems, test systems, equipment, devices, materials, parts, and personnel to and from the project site at no additional cost to the Owner.

G. Provide and install any software maintenance updates or upgrades to all systems (provided that software updates do not affect the integration with the Avigilon VMS system) at no additional cost to the Owner for this 36 month period.

H. Perform two (2) scheduled preventative maintenance site visits per year during the warranty period for the three systems.

I. Response Times - Normal business hours shall be 7 AM to 5 PM Monday through Friday. Calls for service before noon shall be responded to on-site before the end of the day. Calls after noon shall be responded to on-site by noon the following business day.

J. Provide extra costs for time outside of normal business hours if the Owner requires emergency service.

K. Submit an all-inclusive Annual Maintenance Agreement and software assurance agreement cost for years 4 and 5, including two (2) preventative maintenance sites visits per year in the close out submittals.

L. Submit normal and after hours labor costs and typical costs for equipment for items not covered under the Warranty, like: Acts of God, vandalism, misuse.

1.12 EXTRA MATERIALS

A. Provide one (1) each of the following Hirsch Electronics components to serve as system spares:
   1. SNIB2 - Secure Network Interface Board
   2. MRIB - MATCH Reader Interface Board

3. DS47L-SPX-HI ScrambleProx, High Intensity
4. MR-20LA Card Reader

1.13 ALTERNATES

A. Alternate 2 – Storage/Support/Restroom Facility. All related work on T2.4 for the facility shall not be included in the base bid. This work shall be included in the ALTERNATE 2 bid. This work includes associated fiber modules to connect the facility to the MDF via fiber, panels, cabling, terminations, testing, REX devices, door contacts, fiber patch cords, cat6a patch cords, power supplies, card readers, panic buttons, overhead door contact, CCTV integration, any related boards and modules and back boxes.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Proprietary specification. The awarding authority has voted the Hirsch Velocity Security Management System and related components as a proprietary product for this section to maintain compatibility with existing District infrastructure. The Hirsch Electronics "VELOCITY" Version 3.5 Security Management System shall be a modular and network capable access control and intrusion detection system. The Security Management System shall have the ability of handling facilities with multiple remote sites (3.5 version), controlled access with various reader technologies supported simultaneously, alarm monitoring with text and graphics based annunciation, Photo Call-Up, DVR/NVR and CCTV switcher control that allows for easy expansion or modification of readers, inputs, and outputs. The Hirsch Velocity Server and Velocity software shall be provided by the owner.

B. Acceptable Substitutions: The product(s) specified above have been determined to be in the public interest based on sound reasoning and voted as proprietary by the Owner. Under provisions of Massachusetts General Laws, Chapter 30, Section 39M(b) and Chapter 149, other equal products not named herein, may be considered for acceptance as an equal by the Architect and Owner upon submission of complete product information as described in Section 01 25 13 - Product Substitution Procedures. Further additional information may be requested by the Owner or Architect for determination that the proposed product substitution is fully equal to the specified product(s). There is no guarantee that proposed substitutions will be approved, and the Communications Subcontractor shall not to order any materials until approval(s) are received in writing.

1. Requesting substitutions shall be at the Communications Subcontractor's own risk, with regard to uncompensated delays of the Project. Time will be required for sufficient review and additional requests for information by the Architect and Owner. Delays which result from substitution reviews and resubmissions are not grounds for additional time or cost change orders, and will not be considered by the Awarding Authority.Access Control Manufacturer: Hirsch Identiv, proprietary.

2.2 ACCESS CONTROL COMPONENTS

A. Provide and install all workstations required (Qty 2), with above specified software and hardware. Provide workstation in security office, and in SRO office. Workstations shall have second monitor and dual output video cards provided and installed.

B. Provide all programming required for the Avigilon software interface for Hirsch to direct call up camera views in Avigilon from alarm points. Provide programming for 180 alarm points (at a minimum: all panic inputs from Inovonics devices specified in 282300, all panic button inputs, all exterior doors (with and without card access) and all interior doors with card access, and all hallway, stairwell and vestibule motions, and hallway overhead doors. Include admin office, bank and balcony PE center motions.).

C. Printers: (for each workstation)
1. Report Printer - The computer shall have one parallel or USB printer port, and corresponding printer, Hirsch Model HMS-PLBW Laser Printer, and printer drivers for Windows 7. Provide at security office and SRO workstation locations.

D. UPS:
1. Provide appropriately sized UPS at all workstations (Qty 2).

E. Communications Interface To Field Controllers Supported:
1. RS-232.
2. RS-485.
3. TCP/IP.
4. Dial Up.

F. Control Panel Specifications:
1. The control panel shall incorporate microprocessor-based, digital technology, using high speed processing for maximum reliability.

G. Distributed Intelligence:
1. The system shall use distributed intelligence architecture, with controllers operating independently of one another.
2. Regionalized functions for all controllers connected to an XBox communications loop shall include: Use Count, Absentee Limit, Temporary Days, Passback, and Input/Output linking and shall not require the host to be online for processing and control.

H. Stand Alone Operation:
1. All database information required for stand-alone operation shall be stored at the control panel level. All decision-making shall be performed at the control panel, eliminating the need for degraded mode operation.
2. Proprietary software programs and control logic information used to coordinate and drive system hardware shall be stored in Flash Downloadable Read Only Memory.

I. XML Writer Application:
1. The system shall support as standard sending any or all event and alarm transaction events out of a selected port in a standard XML format.
2. A Time Zone may be defined to limit when this data is exported.
3. Multiple XML Writers may be defined and run concurrently for different applications.

J. MS Message Queue Application:
1. The system shall support as standard sending any or all event and alarm transaction events in a standard XML format to a Microsoft Message Queue.
2. A Time Zone may be defined to limit when this data is sent to the queue.
3. Multiple MS Message Queues may be defined and run concurrently for different applications.

2.3 ACCESS CONTROL SYSTEM CONFIGURATION

A. Computer to Controller Communication Protocols:
1. Communications between the computer and the controller shall be accomplished by Scramble*Net Communications and shall be encrypted using a 64-bit cipher feedback method (HES - Hirsch Encryption Standard). The encryption shall be full time and not require any programming or key setting to operate.
2. The system shall utilize RS232 up to 50' for hardwired applications.
3. The system shall utilize RS485 up to 4000' (4-wire hardwired). Longer distances are allowed with a communications multiplexer / amplifier (Hirsch Model NET*MUX4), if applicable.
4. The system shall utilize TCP/IP for communicating over dedicated or shared Ethernet networks.
5. All of the communications protocols shall be supported simultaneously on the system.

B. Host Computer to Controller Communication Transmission Methods/Hardware:
1. Communications between the computer and the controller shall be able to use any or all of the following methods:
   a. Hardwired.
   b. Leased line modem.
   c. Fiber Optic.
   d. Microwave.
   e. RF.
   f. Ethernet 10/100.
   g. Dial-Up modem.

C. Proprietary Network Interface Hardware:
1. The controller shall be interfaced to an industry standard personal computer running proprietary software with the addition of an opto-isolated network communications interface board (Hirsch Model: SNIB). The Scramble Net Interface Board will accept RS232 or RS485 communications interface. Each board is uniquely addressable through on-board dipswitch settings and has an adjustable baud rate from 1200 - 19,200. The board shall be mounted in the controller cabinet and connect to the controller board via an expansion bus cable.
2. The enhanced SNIB2 communications interface board shall be installed for 10/100 Ethernet, 128 Bit AES encrypted communications input to the controller. Downstream RS485 hardwired communications to controllers daisy chained off the "master" controller on any communications port can communicate up to 115 K Baud. The SNIB2 board firmware will be Flash Downloadable to accommodate any future communication enhancements.

D. Maximum System Wide Capacities:
1. The following shall be the maximum system wide capacities. These capacities will be inherent to the software and do not require additional licensing by the manufacturer. The actual number shall be dependent upon the mix of controllers that make up the system:
   a. Doors: Unlimited.
   b. Supervised Alarm Inputs: Unlimited.
   c. Control Relays: Unlimited.
   d. Controllers: Unlimited.
   e. Users: Unlimited.

2.4 ACCESS CONTROL HARDWARE REQUIREMENTS

A. Controllers:
1. There shall be three primary types of controllers:
   a. Access control (1 Door [Hirsch Model M1N2], 2 door [Hirsch Model M2N2] and 8 door - [Hirsch Model M8N2].
   b. Alarm monitoring (16 supervised inputs - [Hirsch Model M16N2]), expandable to 32 inputs.
   c. Relay control (8-32 relay [Hirsch Model MSPN-8R] with the addition of REB8 relay expansion boards and (64 relay - [Hirsch Model M64N]).

C. Each controller shall have the following common features.
1. Controller Board: The controller board shall be microprocessor based, incorporating Flash ROM (firmware) downloadable from the Host Computer, RAM (User Information, System Setups, Event Transaction Buffer) and a Clock/Calendar. The ROM shall be modularly upgradeable in the field for enhancements to system features. All powered connections to the controller board shall be protected by fuses. All wiring connections to the controller board shall be to "Phoenix" type screw terminals. Each door connection shall consist of terminals for two readers, one 10 Amp rated Form C dry output relay for lock control, and one input for monitoring a status switch, a request-to-exit device, and a tamper switch. There shall be status indicator lights for active relays, as well as diagnostic indicator lights to aid in system troubleshooting. There shall be dedicated alarm output relay/s for external reporting of the following conditions: Alarm; Duress; Tamper; and Trouble.
2. Enclosure: The controller enclosure shall be a NEMA style metal cabinet designed for surface mounting. It shall have a tampered, removable hinged door with a high security key lock. It shall have conduit knockouts to allow from 1/2" to 1" EMT conduit to be used for wire entry into the cabinet.
3. Internal Power Supply: The controller shall have an internal power supply that will accept 50 Hz/ 200 - 240 VAC, or 60 Hz/100 - 120 VAC. The primary side of the power supply shall be protected with a fuse. The power supply shall provide 28 VDC power to the controller board, internal battery charger, selected card readers, and reader interface boards.
4. Standby Battery: The controller shall have an internal standby battery that is capable of running the system during AC power interruptions. It shall be recharged by a charging circuit incorporated into the controller board.
5. Expansion Options: A maximum of five (5) expansion boards can be installed in each controller, with the exception of four (4) in the Model M64N2 and none in the Model 1N2. A SNIB2 (SCRAMBLE*NET Interface Board) is included with each controller with the "N2" designation in the part number and takes up one of the available expansion slots.
6. Alarm Inputs: The controller shall be capable of accepting up to 32 additional supervised alarm inputs, in increments of eight (8). The sensitivity of the line supervision shall be 2% AA Standard. The alarm expansion boards shall be mounted in the controller cabinet and connect to the controller board via an expansion bus cable. This option shall be limited to 16 additional supervised alarm inputs for the 16 zone alarm input controller (Model M16N2) and none for the Model M1N2. The alarm expansion board shall be Hirsch Model AEB8.
7. Relay Output: The two (2) access control (Model M2N2 and Model M8N2) and one (1) alarm monitoring (Model M16N2) controllers shall be capable of accepting up to 32 additional Form C, 2 Amp rated relay outputs in increments of 8. The 1 - 32 relay controller (Model MSPN-8R) shall accept up to a maximum of 24 additional Form C, 2 Amp rated relay outputs in increments of 8. The 1 - 64 relay controller (Model M64N2) and the Model M1N2 shall not accept any additional relay outputs. These outputs shall

be used for control applications other than standard door access, such as elevator floor control, local door annunciators and, HVAC interface. The relay expansion boards shall be mounted in the controller cabinet and connect to the controller board via an expansion bus cable. The relay expansion board shall be Hirsch Model REB8.

8. CODE/Buffer: The controller shall be capable of expanding the CODE database up to a maximum of 132,000 Users with the addition of a memory expansion board. The board shall be mounted in the controller cabinet and connect to the controller board via an expansion bus cable. The CODE/Buffer ewxpansion board shall be Hirsch Model MEBCB64 (64,000 Users) or the MEBCB128 (128,000 Users). Both Expansion Boards shall expand the Buffer capacity as well as the Code record capacity. The Model M1N2 shall not accept any CODE/Buffer Expansion board.
9. Event Transaction Buffer: The controller shall be capable of expanding the event transaction buffer up to a maximum of 20,000 events and 2,000 alarms with the addition of a memory expansion board. The board shall be mounted in the controller cabinet and connect to the controller board via an expansion bus cable. The event transaction buffer expansion board shall be Hirsch Model MEBBE. The Model M1N2 shall not accept a Buffer Expansion board.
10. Intelligent Reader Interface: The control panels shall utilize an intelligent reader interface (Hirsch MRIA or MRIB) to communicate with card readers of various types. The interface shall be microprocessor based and allow data formats including ABA magnetic stripe, Wiegand (26 to 55 bit), Proximity, Bar Code, Touch Memory, RF and Biometric. The interface shall utilize a digitizing algorithm, which will convert the card data to a unique number, thus, eliminating the need for facility codes. A single interface shall support both entrance and exit readers with keypads associated with each door. The interface shall be U.L. Listed to U.L.294. The reader interface shall be included as standard in all Scramble Pads.

2.5 ACCESS CONTROL CONTROLLER FIRMWARE

A. General Features:

1. The software for the controller shall reside in Flash ROM (firmware) and be located on a plug removable module on the controller board to facilitate easy field upgradeability of the features. All of the necessary software for a fully functional System is located in the controller. The controller firmware shall include the following general features at a minimum and be fully supported by the VELOCITY head-end.
   a. 3 - 15 digit keypad Code's.
   b. Duress digit for keypad Code's.
   c. 150 Time Zones for access restriction and automatic event control.
   d. 128 Access Zones for access management.
   e. 256 Control Zones for alarm and relay management.
   f. 366 programmable holidays this year, 366 days next year. Each Holiday may be assigned to 1 - 4 Holiday Schedules.
   g. Automatic daylight savings time clock adjustment.
   h. 27 different functions for Code's and cards, e.g. access, unlock, re-lock, alarm mask, relay control.
   i. Add user records.
   j. Tag users for annunciation at host computer.
   k. 4,000 Users.
   l. 1500 event, 1500 alarm transaction buffer.

B. Access Control Features

1. The controller shall include the following access control features at a minimum:
   a. Restrict access by: time of day; day of week; door; holiday.
   b. Momentary Access of door up to 8100 seconds.
   c. Extended Access for User Definable Momentary Access duration (requires ScramblePad). ScramblePad will display time remaining on the minute, and annunciate at the defined "Warning Time".
   d. Special Needs Time Extension to provide additional time for Momentary Access and Door Open Too Long for selected people.
   e. Unlock/Re-lock of door by CODE, card or Time Zone.
   f. Door status monitoring shall allow for: door forced monitoring; door-open-too-long monitoring; door-open-too-long while door is unlocked; auto-re-lock of door when opened or closed.
   g. Request-to-exit masks alarm and/or unlocks door.
   h. 2 person requirement by door. A user can be defined as Normal, A/B Rule A, A/B Rule B, Executive Override. Can be disabled by Time Zone.
   i. 63 Passback Zones. Can be disabled by Time Zone. A User can designated with Passback Executive Override.
   j. Use Count limits on users
   k. Absentee Rule limits on users.
   l. Temporary Day limits on users.
   m. Occupancy Counting / Minimum & Maximum limits per Passback Zone.
   n. Deadman CODE / Timer.
   o. Threat Levels - 99 Levels may be defined. Based on the Level in effect for the facility, selected readers may be disabled, dual readers in Card/Code Only During Time Zone can require dual, and selected User's Credentials can be disabled.

C. Alarm Management Features:
1. The controller shall include the following alarm management features at a minimum:
   a. Momentarily mask alarm by CODE and/or card.
   b. Mask/unmask alarm by CODE and/or card or by Time Zone.
   c. Alarm device supervised while masked.
   d. Tamper switch on alarm device monitored while masked.
   e. Tamper Input may be configured to operate as a "Latch Monitor" with the appropriate door lock hardware.
   f. Entry/Exit delay per alarm input.
   g. Alarm input triggers relays.

D. Relay Control Features:
1. The controller shall include the following relay control features at a minimum:
   a. CODE and/or card, input, or other relay triggers relays.
   b. Trigger relay/s by time zone.
   c. Relay may be normally de-energized or energized.
   d. Disable relay/s during time zone.
   e. Clear relay at end of time zone.

2.6 ACCESS CONTROL CARD READER/KEYPAD SPECIFICATIONS

A. Readers:
1. The controllers shall accept all of the following reader technologies concurrently: Scrambling Keypad; Mag Stripe; Wiegand; Proximity; Smart Card; Bar Code; Biometrics - Retinal Scan, Hand Geometry, Fingerprint; Radio Frequency. The readers can be used for access control, alarm management, and/or relay control and shall be capable of being used alone (keypad only, card only) or a scrambling keypad and any

other reader technology may be combined to operate as a dual technology reader where two valid IDs (PIN and card) are required.

B. ScramblePad with Proximity Reader:

1. The controller shall be capable of using scrambling keypad readers. The keypad shall incorporate the following features: Scrambling display of numbers 0 - 9 (numbers appear in different location every time it is used); +/- 4 degree horizontal and +/- 26 degree vertical viewing restriction; accept 3 - 15 digit CODEs simultaneously; be disabled for 1 minute and report CODE Tamper violation (guessing CODEs); be disabled and report Physical Tamper violation (attempt to remove keypad from mounting box); silent CODE duress; status LEDs for reporting granted, denied, and overridden transactions, AC Fail, Programming Mode active, responses to Status Request of Alarm Inputs and Relay Outputs; weather resistant; supervised by controller; and built-in diagnostics. The ScramblePad shall include the MATCH Reader Interface functionality for connection of up to two (2) card readers. The scrambling keypad shall contain an integrated proximity card reader. Presentation of the card shall automatically auto-start the scrambling display. The scrambling keypad with integrated proximity card reader shall be the Hirsch high intensity ScrambleProx Model DS47L-SPX-HI designated as CRX on the technology drawings. All installations of the ScrambleProx shall be made weatherproof and shall include the MB8 mounting box.

C. Proximity Reader:

1. CR20L-BL Black Short Range Proximity Card Reader on MRIA MATCH Reader Interface Assembly, which includes mounting Base and Bezel. Supports second reader (such as CR20LA-BL) for entry/exit control (MATCH conector with 6" pigtail indluded). The proxiity reader shall be the Hirsch MR-20LA designated as CR on technology drawings. Provide and install MRIB where required due to space limitations of card reader location.

2.7 Hirsch MB Series backboxes. Provide backboxes and deliver to electrical subcontractor for installation.

2.8 Power supplies, Altronix model required to power devices or equal.

2.9 Provide and install/wire/integrate DPDT door contacts for all door leaves as shown on the drawings. GE model 1076D-G or equal. Provide and install 6 inch by 6 inch back boxes with covers above each doorway with door contacts for security wiring splices and MELM installation. Mount to building structure. No cable splices shall be left above doors unprotected.

2.10 Provide and install/wire overhead door contacts, for all overhead doors as shown on drawings, Sentrol Model 2507AD or equal.

2.11 Provide and install/wire Roof hatch door contacts as shown on the drawings for all roof hatches.Sentrol Model 2507A or equal.

2.12 Install and wire and integrate request to exit devices on all doors with door contacts unless otherwise noted, Bosch model DS/TS 151i or equal.

2.13 Monitoring line modules, above every doorway with door contacts, Hirsch model MELM-1 and MELM-2. Install in 6x6 back box.

2.14 Photo-badge Prox Cards, provide 500, Hirsch model PVC-CP-H or equal

2.15 Provide and install ‘panic button’ devices in locations marked as PB on the drawings to allow the owner to immediately initiate a lock down of the access control system as per owner’s direction. Provide press button devices with a guard or shield to avoid accidental triggering of the system. In the Storage/Support/Restroom Facility, provide an SS-2011 Stopper Station with Bopper Stopper Cover by STI at PB location at 48 inches above the finished floor. Provide with custom label “LOCKDOWN”.

2.16 Provide, wire, integrate and install local door sirens/alarms above the doors as designated on the drawings. Allow the owner to determine when/if the alarms shall be triggered when a door is opened that has an alarm/siren installed. Sirens (SI symbol on the drawings) shall be flush mount type:

A. Provide 15W sirens placed above each doorway as indicated on the drawings.
   1. SPL (dB): 105
   2. Tone: Yelp & Steady
   3. Power(W): 15
   4. Material: ABS
   5. Dimensions: 4'W X 4'H X 2'D (10.2 X 10.2 X 5.1 cm)
   6. Siren shall sound local alarm upon unauthorized egress. Siren shall be reset via the access control system (card presentation or programming) or key switch if present.
   7. Provide and install power supply for sirens; battery powered models are not acceptable.

2.17 Provide the following input/outputs:

A. 8 outputs from access control to intrusion
B. 8 inputs at access control for 8 outputs from intrusion
C. Output from access control to input at intrusion for lockdown central monitoring notification
D. Output from access control to Avigilon input module for lockdown notification. Coordinate with 282300 subcontractor.
E. Two outputs from access control to PA system for lockdown integration
F. Five outputs from access control to IPTV system for lockdown integration
G. Inputs at access control for all motions in stairwells, vestibules, hallways and as noted on the drawings
H. Outputs and inputs at access control for three (3) elevators controls (all elevator card readers (one per floor per elevator) and elevator parking. Provide any cabling required to allow the access control system to ‘park’ the elevators on a particular floor, and to park the elevators on a particular floor during a lockdown activation.
I. Provide and install output from access control to the fire alarm control panel input module for lockdown signal from access control to allow fire alarm control panel to drop doors off mag hold opens upon lockdown signal.

2.18 Provide and install a networked temperature probe in all IDFs and the MDF. Probe shall be installed to a relay input and Hirsch shall report high temps as directed by owner.

2.19 Door Operators/Actuators

A. Integrate door operators and actuators into access control for proper operations. Video entry system (see below) shall be programmed to have 2 buttons used for the main entry door to be released, and the inner door to be released. Owner shall have the option to have access control run the operator at either or both doors if desired during the programming phase. Coordinate door operation in regards to door operators with owner. Actuators shall only be operative after a valid card read or in a portal unlocked state. Program a delay after a valid card read before the operator functions according to the owner’s direction. See drawings and door hardware specifications 087100 for doors with actuators, operators and electrified hardware.

2.20 VIDEO ENTRY SYSTEM

A. General

1. Furnish and install a complete video/audio entry intercom system with independent door release mechanisms according to the following specifications. Manufacturer's names and catalog numbers used herein establish the required type, quality and operating characteristics. Provided system shall have at a minimum the following functional capabilities.

B. The Three (3) indoor room stations (locate at VCS symbol locations) shall be complete with handsets, 7" touchscreen color desktop mounted video monitor receivers, door release buttons and desk stands. Provide and install:

1. One (1) Aiphone 7" touchscreen color master control station with desk stand, part number JP-4MED with power supply (part number: PS-2420UL – provide 2 power supplies)
2. Two (2) Aiphone 7" touchscreen color sub-monitors JP-4HD each with desk stands.
3. One RY-3DL selective door release adaptor.
4. Three (3) desk stands (part number MCW-S/A)

Units will be desk top mounted. Door release buttons will release lock on the main entry door with video entry station JP-DVF (C100A1 (both leaves)), another button shall independently release the second entry door (C100A3 (both leaves)) and a third button shall independently release the third entry door (C100B1 (both leaves)). Each doors shall be released independently. See VCS symbol on technology drawings in administration area for control station locations. Use A3 (See technology drawing) at those locations to bring wiring to the control stations as indicated in paragraph D below. Provide all programming of buttons for desired functions.

C. The remote video door stations shall be complete with pan/tilt/zoom color camera, or audio function only as specified below. They shall have vandal resistant hardware. Provide and install:

1. One (1) Aiphone video entry door station outside main entryway C100A1 as shone by VES symbol. Station shall have tamper proof stainless steel housings. Aiphone part number JP-DVF. Coordinate back box location and installation with electrical subcontractor. Door release shall unlock both leaves.
2. Two (2) Aiphone audio entry door stations one each outside doors C100A3 and C100B1. Independent door releases shall unlock both leaves of each doorway. See AES symbol on drawings. Coordinate back box location and installation with electrical subcontractor. Aiphone part number GT-D.

D. The following hardware will be utilized to support the video entry system.

1. Manufactures wiring extends the warranty and shall be used when ever possible. Aiphone #87180250C, 2 cond 18AWG solid PE insulated, non shielded and CAT5e cable (CAT5e is non Aiphone brand).

2. Utilize 2 blank ports on each A3 faceplate for wiring each VCS to its respective cabling.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 INSTALLATION

A. Install system in accordance with manufacturer's instructions and recommendations.

B. Install wiring for detection and signal circuit conductors in conduit. Use 22 AWG minimum size conductors.

C. Make conduit and wiring connections to existing door hardware devices when required. This includes the wiring and installation and integration of rex devices whether in door hardware or IR above door devices, door contacts (must be DPDT, with 2nd set for intrusion detection system) where provided.

D. Door prep for door contacts will be provided under the door hardware scope of work. Power for access control power supplies will be provided by the electrical subcontractor. Access control power supplies shall be provided, connected and wired by the communications subcontractor of this section.

E. Wiring:
1. Use stranded wire only.
2. Use color coded wires. Maintain color-coding throughout system.
3. Minimum Wire sizes: Unless a specific wire size is required by the device manufacturer, use the following minimum sizes.
   a. 16 gauge wire for low voltage power.
   b. 16 gauge twisted pair for polling loop.
   c. 16 gauge wire for keypad loop.
   d. 24 gauge 4 conductor for phone line.
   e. 12 gauge from breaker to security control panel.
   f. Use heavier wire when recommended by Electrical Engineer or required by code.
4. Minimize splices.
5. Tin ends of wire before connecting to terminals.
6. Maximum length of wire runs, combined, for polling loop shall be 2000 feet. One loop extender can be used to extend length by 1200 feet for a total of 3200 feet. Further than 3200 feet, additional central processor(s) are required.
7. All wiring shall be neat, orderly and installed in a professional manner. Cross connections at doorways shall be inside 6 inch by 6 inch back box.

F. Grounding:
1. Ground system to metal cold water pipe with copper strap or to AC third wire ground.
2. Unless otherwise specified by manufacturer, terminate shields at the security control station and insulate at the field device to provide a floating ground.

G. System shall be provided with a battery allowing the system to operate up to eight hours with no utility power.

H. Provide technician for programming sequence operations, camera macros, alarm management, loss of signal handling, and alarm priorities. Coordinate all programming with owner.

I. Coordinate with owner for exact location and arrangement of display & control equipment for Security Control Locations.

J. Test all system components and connections using methods as recommended by manufacturer..

K. Test the entire system, to include camera call up integration between Hirsch and Avigilon.

L. All panels shall have the configuration of each input/output and access control identified and affixed to the inside cover.

3.3 FIELD QUALITY CONTROL

A. Test in accordance with NFPA 72 - National Fire Alarm Code

B. Test in accordance with Hirsch Electronics testing procedures for "Velocity Security Management System".

C. Adjust all security devices to achieve proper operations.

D. Set status (delay, instant, interior and exterior) of each alarm device.

E. The specified equipment shall be supplied, installed, adjusted, tested, and guaranteed by a factory authorized communication subcontractor for the products furnished.

F The communication subcontractor shall be responsible for verifying the completeness of the parts list and the suitability of the equipment to meet the intended purpose of the specifications and to serve the best interests of the owner.

3.4 TRAINING

A. Provide 16 hours of access control training in 4 hour blocks

B. All training materials shall be provided to the owner in digital format, and all training shall be video recorded and provided to the owner on DVDs.

3.5 MANUFACTURER'S FIELD SERVICES

A. Provide manufacturer's field services for final system checkout and acceptance testing for the three systems

3.6 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

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SECTION 28 16 00

INTRUSION DETECTION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of a Contract, including conditions of the Contract and Division 1 of the Specifications, shall apply to the Work in this Section

B. Drawings and general provisions of the Contract, including all portions of the Project Manual are hereby made a part of this Section. Refer to paragraph titled “Quality Assurance” in this section and to Division 1 for requirements for Communications Subcontractors. Throughout this and related Sections, “Subcontractor” shall not be limited to the singular and masculine and shall refer to one, or more than one, Communications Subcontractor. The Terms “Communications Subcontractor” and “Communications System Integrator “ shall be used interchangeably and shall be understood to represent the communications subcontractor responsible for the furnishing, configuring, testing, programming, warranting and ensuring all work is performed in accordance with manufacturer’s requirements and recommendations for the work identified in this SECTION.

C. Any qualifications or certificates required in this specification may be requested by the Architect as part of the post-bid qualifications review. Such review shall commence subsequent to the bid submission, as none of this information is required as part of the bid submission. In the event that the Architect requests qualification or certification documentation such documentation shall be provided within 3 business days.

1.2 SUMMARY

A. Work Included. Any and all cabling mentioned herein and required to complete the work of this section shall be coordinated with the communication subcontractor of this section, and provided and installed by the Structured Cabling communication subcontractor of section 27 10 00 so long as it does not void any manufacturer warranty. The communication subcontractor of this section is responsible for any cabling required by the manufacturer to ensure manufacturer’s warranty. The scope of work of this Section consists of the installation of all materials to be furnished under this SECTION, and without limiting the generality thereof, consists of providing all labor, materials, equipment, plant, transportation, appurtenances and services necessary and/or incidental to properly complete all cabling work as shown on the drawings, as described in the specifications, or as reasonable inferred from either or, in the opinion of the Owner, as being required and in general, is as follows:

1. All security system wiring, addressable motion detectors (motion detectors in hallways, stairwells and vestibules require 2 outputs, the second output shall be to the access control system), security system panels and interfaces, keypads, addressable contact modules, addressable loop regenerator, integrations with the access control system and CCTV system, and all related equipment, to complete installation and testing of the systems to be used as a complete intrusion detection system. If a second output on the motions is not possible, then outputs from Intrusion to Access control for each of the motions is required to be provided and installed.

B. The work of this section is shown on Technology Drawings designated by a T.
C. No corridors or spaces are air plenums. No cabling needs to be plenum rated.
D. All equipment and materials used shall be standard components, regularly manufactured, and regularly utilized in the manufacturer's system.
E. Provide in addition to all relays required for a fully functional system in the MDF 10 alarm inputs for access control, 10 alarm outputs to access control, 10 spare alarm inputs and 10 spare alarm outputs.
F. Provide all patch cords to network switches for intrusion devices that have network connectivity.
G. Central processor assembly
H. Addressable motion detectors (stairwells, vestibules, hallways and other motions noted on the drawings require an addition output to access control).
I. LCD keypads
J. TCP/IP transmission module
K. Printer module and printer
L. Power modules
M. Installation, programming and training
N. Remote power supplies
O. Motions and door contacts shall be individually reportable in the system
P. Coordinate with the owner all zone programming requirements.
Q. Every wired contact and motion detector shall be individually ID reportable. communication subcontractor of this section shall provide a laminated color coded map for each floor, no smaller than 21x15, which clearly shows all doors with door contacts by door number/contact ID number, all motion detectors with ID number, room numbers, hallway numbers, building 'zones', and keypad locations/ID numbers. Mount maps as directed by Owner.
R. Door contacts (double pole double throw) are provided and installed by 281300. Second set of contacts for intrusion system are wired and installed by communications subcontractor of this section.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. All Sections of Division 27.

B. SECTION 01 23 00 – ALTERNATES

C. The following related work or material shall be provided under the designated trades and under the listed SECTION:

1. SECTION 26 00 00- ELECTRICAL All electrical work related to items in this Section.
   a. Coordinate with the electrical subcontractor to hardwire power to each panel from the emergency generator circuit in each room (AC condensate pump circuit). Panels shall not be plugged into the wall outlets.
2. DIVISION 8 – Door Hardware
3. SECTION 14 – Elevators
   a. Coordinate work with elevator contractor to provide card readers and elevator car control outside every elevator door on every floor.
   b. Coordinate with elevator contractor to provide and install specified elevator car cameras in this section.
4. SECTION 28 13 00 Access Control (Access control provides DPDT door contacts, roof hatches and overhead door contacts. One set of contacts is for Intrusion Detection system).
5. Drawing A7.11 and A7.12

1.4 REFERENCES

A NFPA 70 - National Electrical Code.

1. UL294 - Standard for Access Control Systems.
2. NFPA 72 - National Fire Alarm Code.
3. NFPA 101 - Life Safety Code.

1.5 REGULATORY REQUIREMENTS

A System shall be UL-Listed.

B. Intrusion system shall meet UL-610 Central Station Alarm System

1.6 SYSTEM DESCRIPTION

A. General: This system shall provide a complete cabling infrastructure system for an intrusion detection system. Furnish and install complete systems consisting of cabling, devices, and programming. Coordinate with the owner specific zoning requirements of the system. All motions shall be placed to minimize false alarms. Coordinate placements with architect if required.

1.7 SECTION INCLUDES

A. Central processor assembly.

B. Addressable Motion Detectors

C. Addressable Contact Module

D. LCD Keypads

E. Printer Module

F. TCP/IP Transmission Module

G. Re power Modules

H. Installation, Program and Training

I. Remote Power Supplies

1.8 SUBMITTALS

A. Architect may require submittal submission within 45 days of bid award. Submit the following under provisions of Section 01 33 00- SUBMITTAL PROCEDURES with tabulated and indexed pages. Show reference to specification section in index. Any submittals received non-tabulated or indexed shall be returned without action.

B. Manufacturer's Data:
1. Submit :
   a. Product Data Sheets.
   b. Installation Instructions.
2. Manufacturer Certificate and Certified Training Certificates of communications

contractors who will be providing, programming and warranting the equipment.

C. Shop Drawings:
1. Submit three (3) digital copies in AutoCAD 2010 or later on a CD of shop drawings, including:
   a. Layout of equipment on supplied AutoCAD drawings, include labeled wiring risers showing all equipment.
   b. Equipment elevation drawings.
   c. Field Controller equipment location wall layouts, including size requirements.
   d. Detailed wiring diagrams of all devices, Field Controllers, Door integration details, and head-end devices,IDF and MDF closets.

D. Closeout Submittals:

1. As-Built Drawings: Update Shop Drawings to create final As-Built Drawings. Submit 3 copies digitally in AutoCAD 2010 or later format on a CD.

2. Operation Data: Include three (3) copies of the software Administrator and Operator Manuals.

3. Maintenance Data: Include three (3) copies: maintenance and repair procedures.

4. Digital copies of all training materials and DVD videos of all training provided on CD and DVDs.

5. Estimated costs for maintenance and software assurance for the three systems on a yearly basis. List each system independently (access control, intrusion, video surveillance). Cost shall include 2 yearly visits for preventative maintenance.

6. Submit costs for repairs and service not covered under warranty (ie: owner requested changes, acts of God, vandalism, misuse).

7. Warranty certificate with contact numbers with appropriate start and stop dates

8. PDF of product data and O&M manuals shall contain bookmarks for every section and item submitted.

1.9 QUALITY ASSURANCE

A. Manufacturers: Manufacturer shall be a single-source manufacturer for the system, that specializes in intrusion detection with a minimum of 5 years in the industry.

B. Communication subcontractor: Company specializing in intrusion detection and access control systems with a minimum of three years experience on systems of similar size and scope. Communications subcontractors working on project must have been certified by the manufacturers on the hardware and software used for this project.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Owner will provide, on-site, a secure, dry, locked storage area for all equipment delivered under this scope of work.

B. Store products in manufacturer's unopened packaging until ready for installation.

C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.11 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.12 WARRANTY AND SERVICE AGREEMENT

A. All equipment, materials, and labor shall be guaranteed for a period of 36 months from the date of final acceptance by the Owner. Warranty shall begin at this time, not the date of substantial completion. Systems must be fully operational, and accepted by the owner after training before the warranty is to begin.

B. The manufacturer or communications subcontractor shall repair or replace malfunctioning products at no expense to the Owner, except failures caused by damage or unreasonable use.

C. Communications subcontractor shall maintain regular service facilities and provide a qualified technician familiar with the work at the site within 24 hours of receipt of a notice of malfunction, excluding weekends and holidays.

1. Provide material, devices, equipment, and personnel necessary for repairs.

D. Provide accepted temporary, alternate equipment, if required by the Owner, complete and operational within 48 hours after notification of malfunction, at no additional cost during the first year of warranty.

E. Communications subcontractor shall conduct warranty repairs and service at the project site unless prohibited by manufacturer’s warranty. If the latter, communications subcontractor shall provide substitute systems, equipment, and devices acceptable to the Owner for the duration of the off-site repairs. Replace items out of service more than 10 days with new equipment during the warranty period.

F. Communications subcontractor shall transport warranty equipment, substitute systems, test systems, equipment, devices, materials, parts, and personnel to and from the project site at no additional cost to the Owner.

G. Provide any software maintenance updates or upgrades to all systems at no additional cost to the Owner for this 36 month period.

H. Perform two (2) scheduled preventative maintenance site visits per year during the warranty period for the three systems.

I. Response Times - Normal business hours shall be 7 AM to 5 PM Monday through Friday. Calls for service before noon shall be responded to on-site before the end of the day. Calls after noon shall be responded to on-site by noon the following business day.

J. Provide extra costs for time outside of normal business hours if the Owner requires emergency service.

K. Submit an all-inclusive Annual Maintenance Agreement and software assurance agreement cost for years 4 and 5, including two (2) preventative maintenance sites visits per year in the close out submittals.

L. Submit normal and after hours labor costs and typical costs for equipment for items not

covered under the Warranty, like: Acts of God, vandalism, misuse.

1.13 Alternate 2 – Storage/Support/Restroom Facility. All related work on T2.4 for the facility shall not be included in the base bid. This work shall be included in the ALTERNATE 2 bid. This work includes associated intrusion panels to connect door contacts to the intrusion system via fiber or the schools network, fiber modules, if required, motions, cabling, terminations, back boxes and testing.

PART 2 PRODUCTS

2.0 MANUFACTURERS

A. Intrusion Detection Manufacturer: DMP or equal by DSC or Bosch.

2.1 Security Control Panel

A. The base panel shall have a capacity of 16 independent door/keypad addresses, each with four zones. The system shall offer a seamless integrated compatibility with hard-wired and / or wireless zone expansion equipment for at least 200 wireless zones and / or a maximum of 574 hardwired zones.

B. All zones shall be fully supervised and programmable. Panel shall be complete with integral power supply and supervised battery charger, auxiliary power for powering security detection devices, programmable switched auxiliary power supply for 4-wire smoke detectors, integral supervised digital alarm communicator, supervised bell/siren output, and two general purpose programmable outputs which can be programmed as general purpose outputs or as the system's addressable loops. DMP Model XR500N Series or equal, Panel Modules: DMP Model:400 Series or equal by DSC or BOSCH.

C. A 120v circuit for hard wired power is provided at every plywood back board in the MDF and IDFs. Coordinate power connections with electrical subcontractor. No panels shall be ‘plugged in’ to electrical outlets.

2.2 System Communication Bus

A. The system shall be complete with a standard, non-shielded, 4-conductor station wire bus for powering and communicating with remote hardwired system expansion modules and devices. For the connection of various system modules, communication bus wire runs (#18AWG) of up to 2500 ft shall be standard, and the system shall allow for an additional 1200 ft of communication bus wire for each communication bus expander added.

2.3 Voice-Assisted Status & Control

A. The system shall be capable of providing system status and control via any local or remote tone telephone, with the system providing system status information by voice. The system shall include a prerecorded word library from which words can be selected to create zone labels.

2.4 User Codes

A. The system shall provide for 1,500 user codes, select-able as either 4 or 6 digits. User codes shall be assignable to one or multiple partitions.

2.5 Partitions

A. The system shall be programmable for up to 16 fully in-dependent partitions, with each partition having its own account code. Keypads shall be assignable as partition keypads or global keypads. Each zone in the system shall be assignable to one or more partitions.

2.6 Scheduling

A. The system shall provide for 99 date schedules with 4 intervals per schedule, 4 holiday schedules with 2 years of scheduling capacity, 50 open/close suppression schedules and 16 automation schedules. All schedules shall be programmable from the LCD system keypads and by either local or remote upload/download.

2.7. Ground Fault Detection

A. The system shall include an integral ground fault detector which shall detect a single ground fault on any extended conductor in the system.

2.8 Supervision

A. Each zone in the system shall be supervised. The base panel and any remote panel with its own AC input shall be supervised for AC loss. Batteries for the base panel and all remote panels shall be supervised for low power and be short circuit-protected. Each addressable device shall be supervised for its presence.

B. The communications bus shall be supervised for low voltage and the presence of each enrolled module and keypad.

C. Digital alarm communicators shall be supervised for telephone line trouble and failure to communicate. Provide and install phone service provided by owner to control panel for central station reporting.

2.9 False Alarm Prevention

A. The system shall include the following false alarm prevention features:

1. audible exit delay, audible exit fault
2. arm/disarm bell squawk
3. urgency on entry delay
4. TLM trouble and low battery trouble transmission delay
5. swinger shutdown programmable by zone
6. transmission delay by zone
7. police code (cross zone) transmission
8. opening after alarm transmission
9. recent close code transmission
10. AC fail

2.10 Power Supply/Relay Output Modules

A. The system shall be capable of including up to 64 fully programmable output relays with form 'C' contacts rated 2 Amps at 30VDC.

B. Relays shall be added in modules of four and may be located anywhere on the communication bus.

C. Each module shall include a supervised 700mA 12VDC battery charger, and integral power supply to supply up to 2.2 Amps of auxiliary power at 12VDC to power directly connected devices or re-power the communication bus. All panel batteries shall be provided and installed in each panel.

2.11 Low Power Outputs

A. The system shall be capable of including up to 144 low power outputs with each output able to supply 50mA at 12 VDC. Outputs shall be added in increments of 16 and may be added anywhere on the communication bus.

2.12 System Event Buffer

A. The system shall have a 3,000-event buffer. All events shall be printable from the system printer. The 2,800 most recent events shall be viewable on the LCD sys-tem keypad. All events shall be viewable by up-load/download to a PC.

2.13 System Programming

A. The system shall be fully programmable from the LCD keypads and shall also allow event buffer viewing at the keypads.

B. Separate PC-based upload/download software shall allow programming and operation from a directly connected local computer, or from a remote computer via a telephone line or TCP/IP LAN/WAN communications. Provide and install client software)if required) where directed by the Owner (up to 3 locations) to allow system programming via the LAN

C. Remote access shall be controlled by the owner to prevent unauthorized access.

D. All system programming shall be maintained in non-volatile memory so that programming information is retained even if all AC and battery power is removed.

2.14 System Keypads (Symbol KP on drawings)

A. The system shall accommodate up to 16 LCD keypads which are powered from the base panel four-wire communications bus.

B. LCD keypads shall have a display capacity of at least 32 alphanumeric characters with adjustable brightness and contrast.

C. Keys shall be backlit for low light ease of use. Keypads shall include individual "Armed", "Ready" and "Trouble" indicators, three keypad-activated alarm keys, and five programmable function keys. DMP Model:7060A or equal by DSC or GE.

2.15 Central Station Reporting

A. The system shall provide high speed 10 bps and 20 bps 1400/2300 Hz handshake, Contact ID and SIA reporting formats and shall be capable of being programmed to call up to 3 telephone numbers.

B. The system shall also allow communication to a pager. The telephone numbers shall be programmable for backup dialing should the primary number fail.

C. The system shall be programmable for split reporting so that alarms/restorals, openings/closing and miscellaneous events can be sent to different telephone numbers.

D. The system shall report a separate account code for each partition and for non-partition (system) events.

E. The system shall provide opening/closing scheduled suppression to prevent opens and closes from being reported to the central station.

F. The system shall be capable of reporting all alarms, troubles, and system status information by combinations of all communication methods installed including: TCP/IP, phone line, digital communicator, DVACS, and Cellemetry.

2.16 TCP/IP LAN/WAN Communications

A. The system shall communicate all alarm signals to a central station and dedicated PC a constant connection providing full supervision of the link between the panel and the TCP/IP receiver.

B. Communication shall be via a LAN or WAN, compatible with 10BaseT and 100BaseT Ethernet TCP/IP communications.

2.17 System Printer

A. The system shall have a serial printer installed in the security control room that prints all system events, alarms and restorals, including the partition, date, and time of these events.

2.18 2-Way Serial Port

A. The system shall support a 2-way data port, offering RS-232 serial communications at data transfer rates of from 300 to 4800 bps. This port shall provide real-time access to all system events and allow communications subcontractors to send control commands to the control panel.

2.19 System Software

A. The base panel shall come complete with the software necessary to implement every system feature and to allow for the addition of every expansion or functional module without changes or addition to the basic software.

2.20 Motion Detectors (Symbol MO in a hex on the drawings)

A. Ceiling mounted 360 degree detection area for a 24ft coverage area. Wall mounted where shown on the drawings. DMP Model AP669 or equal by DSC or GE with zone expanders in quantities necessary for design intent. Provide motion detectors with two outputs (one for access control system) in hallways, stairwells and vestibules, and where noted on the drawings, or security panel outputs for these motions to the access control system. Provide outputs in quantities necessary for design intent.

B. The communications subcontractor of this section shall ensure proper placement of motion detectors in regards to windows, heating and ventilation registers, and other heat/cold sources to minimize false alarms. Drawings are for a schematic of desired coverage only, the actual placement and design will be the responsibility of the communications subcontractor of this section and in accordance with normal industry practices. Bring all conflicts or gaps in coverage to the attention of the architect.

2.21 Addressable Modules

A. Addressable device to monitor alarm, tamper and trouble conditions.

B. Addressable module:shall be DMP 711 Series or equal by DSC or GE.

PART 3 EXECUTION

3.0 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.1 INSTALLATION

A. Install system in accordance with manufacturer's instructions.

B. Use 22 AWG minimum size conductors.

C. Door prep for door contacts will be provided by subcontractor responsible for the door hardware. Power for access control power supplies will be provided by the electrical subcontractor. Access control power supplies shall be provided, connected and wired by 28 13 00 communications subcontractor.

D. Wiring:
1. Use stranded wire only.
2. Use color coded wires. Maintain color-coding throughout system.
3. Minimum Wire sizes: Unless a specific wire size is required by the device manufacturer, use the following minimum sizes.
   a. 16 gauge wire for low voltage power.
   b. 16 gauge twisted pair for polling loop.
   c. 16 gauge wire for keypad loop.
   d. 24 gauge 4 conductor for phone line.
   e. 12 gauge from breaker to security control panel.
   f. Use heavier wire when recommended by Electrical Engineer or required by code.
4. Minimize splices.
5. Tin ends of wire before connecting to terminals.
6. Maximum length of wire runs, combined, for polling loop shall be 2000 feet. One loop extender can be used to extend length by 1200 feet for a total of 3200 feet. Further than 3200 feet, additional central processor(s) are required.
7. All wiring shall be neat, orderly and installed in a professional manner.
8. Maximum length of remote keypad loop is 1000 feet divided by the number of keypad on the loop.
9. Intrusion detection system shall have the ability to dial out and notify police of an alarm condition, or notify local building occupants or both.

E. Mounting:
1. Remote Security Keypad:
   a). Mount height as shown on technology drawings above finished floor unless otherwise required by accessibility code.
2. Motion Detectors:
   a) Mount to suspended ceiling tiles, or permanent ceiling, or wall mount where shown on the drawings at the heights specified on the drawings.

F. Set all motion detectors for minimum sensitivity to prevent false alarm conditions from building HVAC system.

G. Grounding:
1. Ground system to metal cold water pipe with copper strap or to AC third wire ground.
2. Unless otherwise specified by manufacturer, terminate shields at the security control station and insulate at the field device to provide a floating ground.

H. System shall be provided with a battery allowing the system to operate up to eight hours with

no utility power.

I. Install motion detectors to provide the largest coverage area possible at location.

J. Install keypads by all defined doors on the drawings.

K. Provide appropriate power to maintain correct combus and addressable loop voltage based on total system devices.

L. Provide technician for programming sequence operations, camera macros, alarm management, loss of signal handling, and alarm priorities. Coordinate all programming with owner.

M. Coordinate with owner for exact location and arrangement of display & control equipment for Security Control Locations.

N. All panels shall have the configuration of each input/output and motion identified and affixed to the inside cover.

O. ADJUSTING

1. Adjust all security devices to achieve proper operations.

2. The specified equipment shall be supplied, installed, adjusted, tested, and guaranteed by a factory-authorized Communications Subcontractor for the products furnished. The Communications Subcontractor shall be responsible for verifying the completeness of the parts list and the suitability of the equipment to meet the intended purpose of the specifications and to serve the best interests of the owner.

P. Test all system components and connections using methods as recommended by manufacturer.

3.3 FIELD QUALITY CONTROL

A. Test in accordance with NFPA 72 - National Fire Alarm Code

B. Adjust all security devices to achieve proper operations.

C. Set status (delay, instant, interior and exterior) of each alarm device.

D. The specified equipment shall be supplied, installed, adjusted, tested, and guaranteed by a factory authorized communication subcontractor for the products furnished.

E. The communication subcontractor shall be responsible for verifying the completeness of the parts list and the suitability of the equipment to meet the intended purpose of the specifications and to serve the best interests of the owner.

3.4 TRAINING

A. Provide 8 hours of intrusion detection system training

B. All training materials shall be provided to the owner in digital format, and all training shall be video recorded and provided to the owner on DVDs.

3.5 MANUFACTURER'S FIELD SERVICES

A. Provide manufacturer's field services for final system checkout and acceptance testing for the three systems

3.6 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 28 23 00

VIDEO SURVEILLANCE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of a Contract, including conditions of the Contract and Division 1 of the Specifications, shall apply to the Work in this Section

B. Drawings and general provisions of the Contract, including all portions of the Project Manual are hereby made a part of this Section. Refer to paragraph titled “Quality Assurance” in this section and to Division 1 for requirements for Communications Subcontractors. Throughout this and related Sections, “Subcontractor” shall not be limited to the singular and masculine and shall refer to one, or more than one, Communications Subcontractor. The Terms “Communications Subcontractor” and “Communications System Integrator “ shall be used interchangeably and shall be understood to represent the communications subcontractor responsible for the furnishing, configuring, testing, programming, warranting and ensuring all work is performed in accordance with manufacturer’s requirements and recommendations for the work identified in this SECTION.

C. Any qualifications or certificates required in this specification may be requested by the Architect as part of the post-bid qualifications review. Such review shall commence subsequent to the bid submission, as none of this information is required as part of the bid submission. In the event that the Architect requests qualification or certification documentation such documentation shall be provided within 3 business days.

1.2 SUMMARY

A. Video Surveillance System:

1. The CCTV system’s primary function shall be to record/display the appropriate video (both live and recorded), inside the school and the surrounding area. The system shall utilize an integrated Network Video Recording system and surveillance cameras with the specified capabilities.
2. Provide all cameras and equipment as indicated in the specifications, depicted on the plans, or reasonably interpreted by architect/engineer.
3. This is an IP based system. All Category 6A cabling shall be provided, installed and terminated by Section 27 10 00 (except patch cords from terminated horizontal runs from the local IDF and MDF and from switches at poles to cameras mounted to poles. Communications subcontractor of this section shall provide and install outdoor grade Cat6A patch cords from pole switches to cameras on poles, and Cat6A yellow patch cords from structured cable terminations to the camera).
4. Any and all cabling mentioned herein and required to complete the work of this section shall be coordinated with the communications subcontractor of this section, and provided and installed by the Structured Cabling communications subcontractor of section 27 10 00 so long as it does not void any manufacturer warranty. The

communications subcontractor of this section is responsible for any cabling required by the manufacturer to ensure manufacturer's warranty.

5. The camera systems shall be installed and fully operational in the specified locations on the drawings both inside and outside of the building. Each camera shall be wired via Category 6A cable or fiber with media converters unless noted otherwise.
6. Power shall be provided to each camera via **Power over Ethernet switches, provided by the owner (communications subcontractor of this section is responsible for providing PoE switches as specified in this section for cameras at the parking lot poles, if specified)**, or by a power supply (provided by communications subcontractor of this section) where required.
7. Communications Subcontractor must work with owner to define a specific sequence of operations for the camera control system, software client, camera groupings, proper views of each camera, NVR, and manual controls. Operations will include camera tours, sequence for alarm management, if applicable, or loss of signal. Camera controls shall be programmed with macros and programming sequences to provide camera tours, quick call up of cameras, partitioning, and loss of service alerts. All programming and sequencing is included in the bid.
8. Provide enterprise camera licenses for all cameras and enterprise VMS licenses for all NVR and components. One hundred and eighty (180) cameras shall be integrated with access control, for the immediate call up of video upon specific Hirsch alarms to be determined by the owner. Coordinate camera call up programming and camera matrix for software gateway with subcontractor of 28 13 00. The owner shall determine during programming which cameras are to be integrated and called up from which alarms. Provide all enterprise level camera, component device and NVR licenses for the video management system, and all camera and NVR licenses required for the Hirsch Velocity system, if required.
9. The NVR System shall utilize IP based network video recorders (NVR), which will allow simultaneous recording and remote access of live streams for the video cameras.
10. The NVR shall be a true digital system that can receive digital images/video streams over the network and record them in a digital format. Provide video matrix option for the ability of the entire NVR system (all individual NVRs) to be seen as 'one' NVR for various camera groupings and viewing layouts.
11. The NVR shall be compatible with the specified IP cameras. NVR solution shall accommodate the proposed number of cameras plus 5 (per NVR).
12. Viewing and monitoring of the NVR will take place remotely over the Owner's network using existing computers.
13. The NVR system shall be a non-proprietary system. The open-architecture platform shall run on off-the-shelf PC servers and workstations and deliver universal support for IP and encoders for all of the specified manufacturers.
14. Provide 15 remote client licenses and clients to view cameras, if required for the VMS solution.
15. The specifications provided are to provide a general description of the operating criteria of the system. Communications Subcontractor is responsible for providing a fully operational system. Provide appropriate number of NVRs in the storage capacity required for the proposed NVR system for the amount of cameras specified to achieve all criteria specified herein. Stored recorded video shall be for a min of 30 days.
16. Communications subcontractor shall be certified by the manufacturers to test, configure and warrant all components of the specified equipment in this section.
17. All software versions for the video surveillance video management systems shall be updated to be the most recent version at no cost to the owner 1 month prior to school opening. Do not update if the current Hirsch software version is not compatible with the latest Avigilon software.
18. System Administration tasks such as defining user permissions, schedules, generation

of reports, and displaying maps shall be available. System back-up and remote diagnostics shall be included.

19. Mounting Brackets and lenses: Mounting brackets and lenses have been specified on the drawings to indicate the style of mounting for interior and exterior cameras and the types of lenses to be used. Communications Subcontractor is responsible for ensuring that the correct mounts and lenses for the distance requirements are used for the camera system specified.
20. Video Management System shall integrate with Active Directory
21. Current district system has specific cameras report video directly to the police station upon panic button contact closure. Provide all devices and programming to achieve this for cameras located in the Student Dining area, Gym, Library, Auditorium and main office.
22. Communications subcontractor shall change all default passwords on all devices, to include cameras.
23. Communications subcontractor shall set the camera time to the NVR time
24. Communications subcontractor shall use the H.264 video stream as the recorded video stream, recording only on detected motion. Motion mask views as necessary to avoid recordings when no people are present in the camera view.
25. Communications subcontractor shall group cameras as per owner instruction. At a minimum, provide camera groups for: Building perimeter North/South/East/West (NSEW); elevators, floors (1,2,3), Floor hallways (NSEW), Gym, Small Group Seminar, Auditorium, Student Dining, Library, Parking Staff/Student, entries exterior (NSEW), entries interior (NSEW), stairs (1,2,3, 4,5,6…).
26. The work of this section is shown on Technology Drawings designated by a T.
27. Alarms from Hirsch to Avigilon shall be programmed to call up related video, send email alerts with video clips and to call up software maps of the trouble area. Alarm triggers shall alert Police department if directed by the owner. Coordinate alarms to be reported, to whom to be reported to, and emails to be sent and install email distribution list from owner during programming phase.
28. Provide for programming a min of 180 alarms, to include all alarms from the Hirsch system to call specific camera views as related to those alarms. All door alarms shall include camera views of both the inside and outside cameras where applicable.
29. Provide Avigilon alarm gateway to 281300 subcontractor for installation on the Hirsch server.
30. Provide wireless panic button output relays wired to the local Hirsch panel. Coordinate local Hirsch panel with 281300 subcontractor such that the appropriate number of relay inputs are provided by 281300 subcontractor at the Hirsch panel for the wireless panic button integration to Hirsch. Leave relay output wiring coiled at Hirsch panel for 281300 subcontractor to make final terminations into the Hirsch panel.
31. Ensure the Avigilon servers, PCs, recorders and other devices are on the same subnet as the Hirsch servers and components. Coordinate with Owner and 281300 subcontractor.

C. No corridors or spaces are air plenums. No cabling needs to be plenum rated.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. All Sections of Division 27.

B. SECTION 01 23 00 - ALTERNATES

C. The following related work or material shall be provided under the designated trades and under the listed SECTION:

1. SECTION 26 00 00- ELECTRICAL All electrical work related to items in this Section.
   a. Coordinate with the electrical subcontractor to hardwire power to each panel from the emergency generator circuit in each room (AC condensate pump circuit). Panels shall not be plugged into the wall outlets.
2. DIVISION 8 – Door Hardware
3. SECTION 14 – Elevators
   a. Coordinate work with elevator contractor to provide card readers and elevator car control outside every elevator door on every floor.
   b. Coordinate with elevator contractor to provide and install specified elevator car cameras in this section.

1.4 REFERENCES

A NFPA 70 - National Electrical Code.

1. UL294 - Standard for Access Control Systems.

2. NFPA 72 - National Fire Alarm Code.

3. NFPA 101 - Life Safety Code.

1.5 REGULATORY REQUIREMENTS

A System shall be UL-Listed.

B. Intrusion system shall meet UL-610 Central Station Alarm System

1.6 SYSTEM DESCRIPTION

A. Proprietary specification. The awarding authority has voted the Avigilon Video Management System and related components as a proprietary product for this section to maintain compatibility with existing District infrastructure. The Avigilon shall be a modular and network capable video management system (VMS). The VMS shall have the ability of handling facilities with multiple remote sites and allow remote camera viewing. Panic alarms shall trigger video to be immediately presented on the police station monitors, in areas specified.

B. Acceptable Substitutions: The product(s) specified above have been determined to be in the public interest based on sound reasoning and voted as proprietary by the Owner. Under provisions of Massachusetts General Laws, Chapter 30, Section 39M(b) and Chapter 149, other equal products not named herein, may be considered for acceptance as an equal by the Architect and Owner upon submission of complete product information as described in Section 01 25 13 - Product Substitution Procedures. Further additional information may be requested by the Owner or Architect for determination that the proposed product substitution is fully equal to the specified product(s). There is no guarantee that proposed substitutions will be approved, and the Communications Subcontractor shall not to order any materials until approval(s) are received in writing.

1. Requesting substitutions shall be at the Communications Subcontractor's own risk, with regard to uncompensated delays of the Project. Time will be required for sufficient review and additional requests for information by the Architect and Owner. Delays which result from substitution reviews and resubmissions are not grounds for additional time or cost change orders, and will not be considered by the Awarding Authority.

C. The system shall support both manual and automatic responses to alarms entering the system. Each alarm shall be capable of initiating a number of different actions, such as camera switching, activation of remote devices, email of video for alarm/event, texts of alarm/event, and mobile device delivery of alarm/event video.

D. The VELOCITY System shall interface to the CCTV system through a gateway software interface. Provide and install this interface on the Hirsch Velocity Server. The NVR system shall be programmed to respond to the alarm inputs through Avigilon's gateway software. In response to an alarm, the NVR shall record video as programmed, including: Pre-Alarm, Alarm Duration, Post Alarm, and Frames per second as defined for that camera. All control of position, zoom, focus, and iris shall be controlled by the NVR system's keyboard/joystick controls. Initial NVR setup and Advanced programming shall be performed through the NVR's configuration software programming interface. Provide and install the gateway software for CCTV and access control integration of the cameras to be determined by the owner.

E. Utilizing assigned passwords, it shall be possible to define the levels of system operation for each individual Operator. Operator Actions range from basic monitoring to full control of the system databases.

F. The system programming shall be user-friendly Windows environment (use conventional "Title Bar", "Menu Bar", "Tool Bar" and "Status Bar") and allow mouse control of key functions. The programming shall be MENU driven and include on-line "Documentation", "Help" or "Tutorial" information. The software shall utilize combo boxes for previously entered system-required data where applicable.

1.7 SUBMITTALS

A. Architect may require submittal submission within 45 days of bid award. Submit the following under provisions of Section 01 33 00- SUBMITTAL PROCEDURES with tabulated and indexed pages. Show reference to specification section in index. Any submittals received non-tabulated or indexed shall be returned without action.

B. Manufacturer's Data:
   1. Submit :
      a. Product Data Sheets.
      b. Installation Instructions.
   2. Manufacturer Certificate and Certified Training Certificates of communications contractors who will be providing, programming and warranting the equipment.

C. Shop Drawings:
   1. Submit three (3) digital copies in AutoCAD 2010 or later on a CD of shop drawings, including:
      a. Layout of equipment on supplied AutoCAD drawings, include labeled wiring risers showing all equipment.
      b. Rack elevation drawings.
      c. Field Controller equipment location wall layouts, including size requirements.

d. Detailed wiring diagrams of Field Controllers, Door integration details, and head-end devices, camera locations, IDF and MDF closets.

D. Closeout Submittals:

1. As-Built Drawings: Update Shop Drawings to create final As-Built Drawings. Submit 3 copies digitally in AutoCAD 2010 or later format on a CD.

2. Operation Data: Include three (3) copies of the software Administrator and Operator Manuals.

3. Maintenance Data: Include three (3) copies: maintenance and repair procedures.

4. Digital copies of all training materials and DVD videos of all training provided on CD and DVDs.

5. Estimated costs for maintenance and software assurance for the three systems on a yearly basis. List each system independently (access control, intrusion, video surveillance). Cost shall include 2 yearly visits for preventative maintenance.

6. Submit costs for repairs and service not covered under warranty (ie: owner requested changes, acts of God, vandalism, misuse).

7. Warranty certificate with contact numbers with appropriate start and stop dates

8. PDF of product data and O&M manuals shall contain bookmarks for every section and item submitted.

1.8 QUALITY ASSURANCE

A. Communication subcontractor: Company specializing in video surveillance systems with a minimum of three years experience on systems of similar size and scope. Communications subcontractors working on project must have been certified by the manufacturers on the hardware and software used for this project.

B. Propriety specification. The awarding authority has voted the Avigilon Video Management System and related components as a propriety product for this section to maintain compatibility with existing District infrastructure. Communications subcontractors must be certified by Avigilon to provide, install, configure, test and warrant the complete system.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Owner will provide, on-site, a secure, dry, locked storage area for all equipment delivered under this scope of work.

B. Store products in manufacturer's unopened packaging until ready for installation.

C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.10 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.11 WARRANTY AND SERVICE AGREEMENT

A. All equipment, materials, and labor shall be guaranteed for a period of 36 months from the date of final acceptance by the Owner. Warranty shall begin at this time, not the date of substantial completion. Systems must be fully operational, and accepted by the owner after training before the warranty is to begin.

B. The manufacturer or communications subcontractor shall repair or replace malfunctioning products at no expense to the Owner, except failures caused by damage or unreasonable use.

C. Communications subcontractor shall maintain regular service facilities and provide a qualified technician familiar with the work at the site within 24 hours of receipt of a notice of malfunction, excluding weekends and holidays.

1. Provide material, devices, equipment, and personnel necessary for repairs.

D. Provide accepted temporary, alternate equipment, if required by the Owner, complete and operational within 48 hours after notification of malfunction, at no additional cost during the first year of warranty.

E. Communications subcontractor shall conduct warranty repairs and service at the project site unless prohibited by manufacturer's warranty. If the latter, communications subcontractor shall provide substitute systems, equipment, and devices acceptable to the Owner for the duration of the off-site repairs. Replace items out of service more than 10 days with new equipment during the warranty period.

F. Communications subcontractor shall transport warranty equipment, substitute systems, test systems, equipment, devices, materials, parts, and personnel to and from the project site at no additional cost to the Owner.

G. Provide and install any software maintenance updates or upgrades to all systems at no additional cost to the Owner for this 36 month period unless it is specifically not compatible with the installed Hirsch Velocity software version.

H. Perform two (2) scheduled preventative maintenance site visits per year during the warranty period for the three systems.

I. Response Times - Normal business hours shall be 7 AM to 5 PM Monday through Friday. Calls for service before noon shall be responded to on-site before the end of the day. Calls after noon shall be responded to on-site by noon the following business day.

J. Provide extra costs for time outside of normal business hours if the Owner requires emergency service.

K. Submit an all-inclusive Annual Maintenance Agreement and software assurance agreement cost for years 4 and 5, including two (2) preventative maintenance sites visits per year in the close out submittals.

L. Submit normal and after hours labor costs and typical costs for equipment for items not covered under the Warranty, like: Acts of God, vandalism, misuse.

1.12 Alternate 2 – Storage/Support/Restroom Facility. All related work on T2.4 for the facility shall not be included in the base bid. This work shall be included in the ALTERNATE 2 bid. This work includes associated CCTV cameras, patch cords, programming, integration with access control, testing, and aiming of cameras.

PART 2 PRODUCTS

2.0 MANUFACTURERS

A. Video Surveillance Manufacturer: Avigilon with Hirsch Integration

B. Camera Manufacturer: Panasonic, Avigilon, Axis

2.1 VIDEO SURVEILLANCE SYSTEM

A. All licenses (must be enterprise level) and software components and triggers and alarms are required to be provided and installed. Software and hardware triggers are required to be installed and programmed for the cameras to be called up and presented where directed by owner upon triggers determined by the owner.

2.2 SOFTWARE

A. The Communications Subcontractor shall supply the licenses per camera integrated into the CCTV system as necessary, and any licenses required for server/software/remote clients.
B. Provide servers and related components, and install and configure Video Management Software:
1. Software must be open platform
2. Must be a multi-server and multi-site video surveillance solution
3. Optimized recording storage management
4. Must be ONVIF compliant
5. Must support MPEG4, MJPEG and H.264
6. Built-in video motion detection
7. Must provide a bi-directional alarm integration with Hirsch Velocity Access Control system
8. Must support unlimited cameras and remote users
9. Provide unlimited licenses for remote camera viewing, up to 16 camera views per location
10. Provide all licenses for 6 video recorders and unlimited remote users with client software (if required).
11. Provide appropriate Avigilon Control Center software on the NVRs meeting manufacturer recommended specifications. NVR Servers must be rack mounted in 4 post open hole rack in MDF CCTV rack.
12. Provide Avigilon Control Center Software v5.x or later
13. Provide Enterprise Licenses for cameras and server (ACC5 ENT)
14. Provide Avigilon Control Center Client Software v.5.x or later
15. Provide Avigilon Third Party Integration License ACC5-HRSH-VLCTY
16. Provide Avigilon Alarm Gateway software and load on the Hirsch velocity Server provided by the Owner. (AvigilonHirschVelocityGateway.exe or software as appropriate)

2.3 NVR Provide 6
A. General: IP network based Network Video Recorder System “System” shall operate on industry standard Microsoft Windows 2008 server (min) or Windows 7 operating system with all the controls done via keyboard and mouse. System shall not include any proprietary hardware such as video capture or frame grabber cards that may cause System instability. System shall be based on industry standard hardware. Provide and install software and licenses.
1. All System configurations, changes, setups and operation shall be available to the System

administrator for access and use. System configurations, changes, setups and operation shall be password protected.

2. NVR: Min Intel Quad Core Xeon Processor 2. 0GHZ 1066 MHz FSB, min 8 GB DDR2 SDRAM Memory, (2) 1 Gigabit server adapters (NIC cards, server class), min 20 TB **useable** internal hard drive capacity for data storage in a RAID 5 configuration, SATA-II 7200 RPM enterprise class hard drives, min 1TB boot/operating system drive storage capacity in a RAID 1 configuration. Redundant power supplies, DVD-RW drive, 1GB Video Graphics Card, manufacturer supplied 3 year 4 hr response on site 7x24 support. Provide six (6), must be 4 post open hole rack mountable. Tower servers are not acceptable.
3. Provide and install a mobile Server (Windows Server 2008 or Windows 7, Intel Quad Core Xeon 2.0GHz 4GB DDR2 ram, 1GB nic card, nVidia Quadro FX 570 dual DVI video card with SATA-II 7200 RPM HDs) for mobile device app video transmission capability. The system is required to be able to push video to mobile devices. Provide licenses required for the server, and any mobile client licenses that may be required (provide min of 15). Rack mountable server required, mount in 4 post MDF CCTV rack.
4. Provide mouse (1), keyboard (1), 17” LCD color monitor (1). Provide a Keyboard/Video/Mouse rack mount solution for these 7 servers (include Mobile app server) to utilize one mouse, one keyboard and one display, rack mountable.

2.4 UNINTERRUPTED POWER SUPPLY Provide 2 (for 7 servers listed above)

A. General: Each server/PC shall be supported by an uninterrupted power supply (UPS). The UPS shall provide standby power during blackouts, brownouts, surges, spikes and line noise protection.
   1. Shall have built-in DB9 network interfaces to allow remote management and automatic shutdown.
   2. SNMP manageable
   3. Shall contain network card for network management and reporting
   4. Recharge time: 2-3 hours
   5. Back up time: half load 15 min., full load 4 min. Size according to servers supported.
   6. Shall have 208v 30 amp single phase twist lock plugs.
   7. Shall be 4 post open hole rack mounted.

2.5 FIXED NETWORK COLOR CAMERA (Provide QTY 108 model 355s (Symbol C013, C053)), QTY 170 model 346 (Symbol C113, C133)).

A. The semi-flush-mounted vandal resistant digital signal processing (DSP) 1.3 Megapixel cameras shall be Panasonic Model WV-SW355 or equal by Axis or Sony for exterior use, and Panasonic Model WV-SF346 (or equal by Axis or Sony) for interior use. The exterior cameras shall have a sensitivity of 0.3 lux color, .05 lux black and white. The interior cameras shall have a sensitivity of .3 lux color and .2 lux black and white.

B. The camera shall use a Dual Streaming Codec with JPEG and H.264 Video Compression. Camera shall be capable of streaming up to 30ips.

C. The camera's imager and lens assembly shall rotate on a three-axis hinge for optimal camera positioning. The camera shall be able to be semi-flush mounted on a wall or ceiling using a standard double-gang 4-11/16" electrical box. The camera shall feature a rugged weatherproof exterior housing with an advanced dehumidification device, base and body as independent structures, and that meets IP66rating. The vandal resistant camera shall feature a local monitor output jack for picture and positioning adjustments.

D. The cameras shall feature wide dynamic range and smoked domes.

E. The camera shall feature a body-based vandal automatic back focus mechanism for automatic and remote back focus adjustment. The automatic back focus adjustment (ABF) shall engage and reposition the imaging assembly for optimal focus position on automatic or manual switchover from Day to Night Mode and on manual activation at the camera or remote from the camera using a System Controller.

F. The camera shall feature a B/W mode that may be automatically engaged in lowlight level, but also permits the use of an external infrared illuminator, when manually selected. The camera shall incorporate independent automatic Color to B/W switching modes for switchover on light threshold and sensitivity to IR illumination in the 850 nm wavelength (Auto1 and Auto2). Each switching mode shall incorporate two switching threshold light levels, high and low. Each Color to B/W switching mode shall incorporate three duration settings for automated switchover. The camera's video image may be manually changed to upside-down mode to facilitate certain mounting and other applications.

G. The camera shall incorporate a 1/3", 1.3MP imaging device; have progressive scan, automatic iris, 2.8X min variable focal lens with a focal length of 3mm - 8.5mm minimum. The lens shall be suitable for use in areas where there is a varying light source.

H. Provide PoE heater for exterior cameras.

I. The power source shall be Power over Ethernet (PoE). NO independent AC or DC shall be provided at camera locations.

J. Provide PPM484S or equal for each camera, or equal by Sony or Axis, to mount each camera to poles. Provide pathway for cabling from pole base to camera housing by drilling a hole in the pole at the mount location, typically 15’ AFG (12’ AFG for Pole #1). Stagger cameras on pole between 15’ and 17’ as necessary for poles with multiple cameras.

2.6 FIXED NETWORK COLOR CAMERA, ELEVATOR CAR (Symbol C122) (Provide 3)

A. The surface corner mounted vandal resistant mini dome color CCD cameras in the elevators shall be a Panasonic Model WV-SW155 or equal by Axis or Sony. Provide all media conversion equipment, power supplies and coordinate all cabling with 27 10 00 communications subcontractor to connect and integrate elevator cameras to the network and VMS/NVR system. Coordinate with elevator contractor.

2.7 FIXED NETWORK COLOR CAMERA, 2.4MP, 1080P, 60fps EXTERIOR (Symbol C0593 POLE #1 on T2.10) (Provide 1)

A. The pole mounted fixed network color MOS image sensor camera shall be a Panasonic Model WV-SPW631L or equal by Sony or Axis. Camera shall be utilized for traffic monitoring. Adjust image accordingly for best license plate recognition possible.
B. Camera shall be fully powered by PoE (to include heater, if required). See 2.9.C.1 below for connectivity.
C. Provide pole mount PAPM3 or equal by Sony or Axis to mount camera to pole. Provide pathway for cabling from pole base to camera housing by drilling a hole in the pole at the mount location, typically 12’ AFG.

2.8 FIXED NETWORK COLOR CAMERA, 1080P, 60fps INTERIOR (Symbol C1133) (Provide 2)

A. The wall mounted vandal resistant dome color CCD cameras shall be a Panasonic Model WV-SFR631L or equal by Sony or Axis. Camera shall be utilized for facial recognition at main entry. Camera includes IR LED for 0lux recording. Adjust image accordingly for best view of lobby and doorways.

B. Camera shall be fully powered by PoE.

2.9 PTZ PROGRESSIVE SCAN NETWORK COLOR CAMERA (Provide 6) (Symbol C06Z3, C04Z3)

A. The pendant mounted color 1080p 30fps camera shall be a Panasonic Model WV-SW598 or equal by Axis or Sony or equal. Two cameras shall be mounted to the fascia of the pressbox, 4 on building corners and shall include:

1. Pendant, shroud mount
2. Heater, if required
3. Pressbox Camera shall be powered by the PoE+ switch (provided by Owner) inside the pressbox.
4. 1080p HD images up to 30fps
5. 2.4MP, 1920x1080 image size
6. High-Resolution processing by UniPhier
7. Full frame (up to 30fps) transmission at 1920x1080 image size
8. 30x optical zoom
9. 90x extra optical zoom at vga resolution
10. Digital electronic zoom 12x
11. Super dynamic and adaptive back black stretch for 128x wider dynamic range and fog compensation
12. High sensitivity with day/night function: .5lux (color) .06lux (B&W) at F1.6 (Wide)
13. 360 degree endless panning
14. Automatic day/night mode
15. Advanced auto tracking
16. Up to 256 preset positions
17. Face detection function
18. Video motion detection
19. Ip66 rated
20. Progressive scan
21. 3.3mm to 119mm
22. Dehumidification device

B. The integrated housing shall have a polycarbonate lens, cast aluminum body and use tamper resistant hardware. The housing shall have a built in sunshield. The housing shall be weatherproof to IP66.The unitized camera/dome assembly shall be a self-contained unit that incorporates an integral color camera, pan-and-tilt motor, zoom lens and receiver/driver. Provide 2 wall mounts to mount camera to fascia of pressbox where shown on the drawings, provide 4 corner/parapet mounts to install on building corners.

2.10 CAMERA LENSES, MOUNTS, ACCESSORIES AND CONFIGURATIONS.

A. See T2.2 for specific camera mounts and accessory requirements to be utilized on this project.

B. The following accessories and supporting equipment shall be used on this project:

1. Provide and install at each pole that is shown with cameras on T2.10 a longspan poe camera unit, one per camera, in the pole mounted NEMA 4x enclosure (enclosure provided by 271000). Veracity camera units: VLS-1P-C (qty 29 total) by Veracity or equal.
2. Provide and install a cat6 outdoor grade patch cord from the data faceplate (data faceplate provided by 271000) in the NEMA enclosure to each Veracity unit input. Mount each Veracity unit to the NEMA enclosure back plate. Provide and install outdoor grade cat6 patch cord from Veracity output to camera input. Provide pathway for cabling from Veracity unit at pole base to camera mount by drilling a hole in the pole at the mount location, typically 15' AFG (12' AFG for Pole #1). Stagger cameras on poles between 15' and 17' as necessary for poles with multiple cameras.
3. Provide PPM484S or equal for cameras, or equal by Sony or Axis, to mount cameras to poles.
4. In the support/storage facility IDF, install one VLS-1P-B (qty 29 total) per camera in IDF 122F. Install these units in a rack mount (rack mount: provide and install qty 2, VLS-1U). Connect IDF switch (switch provided by owner) to each Veracity unit input with cat6a patch cords. Connect Veracity units output in IDF to corresponding data ports from poles on patch panels in IDF with yellow cat6a patch cords provided by 271000.
5. At press box, for football field, provide and install two WM2400 mounts and provide and install four (4) (two (2) on each WM2400) Videolarm IR200-36, or equal as shown on drawing details. Adjust power to MEDIUM and set angles to 45 degrees. Ensure full coverage of the playing field area with each IR flood slightly overlapping the other. Fully test IR flood and camera functionality during hours of darkness and adjust as per owner's direction. Provide appropriate PB24 power supply for each pair of IR floods (provide two PB24). All PB24s shall be installed on upper deck fascia as shown on the drawings. WM2400 Mounts shall be installed on the front cover of the PB24s.

2.11 CCTV WIRELESS PANIC BUTTON INTEGRATION

A. Provide 14 Inovonics receivers, part number EN4216MR
   1. Install receivers for full building coverage. Wire an alarm output from the receiver to an alarm input on a local camera at the installation area.
   2. Power the receivers from a local IDF outlet (IDF outlets are on generator power). Provide a UPS in the local IDF for the power of the receiver.
B. Provide 10 Inovonics transmitters, part number EN1223S. Coverage areas these will be used: Gym, PE Alternative, Auditorium, Student Dining, Main Office.
C. Programming of the above system shall be provided by Owner.
D. Provide and install one output of each receiver to a local Hirsch panel for input to the Hirsch system for lockdown capability from the panic button. Coordinate type of cable required with 281300. Leave cable 15' coiled above local panel for final connections y 281300. Test outputs to Hirsch and full lockdown initiation and provide documentation that all receivers initiate a lockdown signal to the Hirsch system.
E. Output relay from Hirsch is provided by 281300 subcontractor for lockdown notification to Avigilon system. Install this output to a receiver input to allow lockdown notification from Hirsch to Avigilon system. Coordinate with 281300 subcontractor.

PART 3 EXECUTION

3.0 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.1 INSTALLATION

A. Install system in accordance with manufacturer's instructions.

B. Provide technician for programming sequence operations, camera macros, alarm management, loss of signal handling, and alarm priorities. Coordinate all programming with owner.

C. Provide snap shots of each camera for review of proper initial alignment with architect. Owner shall review and provide final adjustment information. Adjust all cameras in accordance with owner directions.

P. ADJUSTING

1. Adjust all security devices to achieve proper operations. Coordinate with owner for proper camera coverages.

2. Set programming tours, presets, and system macros per direction owner..

3. The specified equipment shall be supplied, installed, adjusted, tested, and guaranteed by a factory-authorized Communications Subcontractor for the products furnished. The Communications Subcontractor shall be responsible for verifying the completeness of the parts list and the suitability of the equipment to meet the intended purpose of the specifications and to serve the best interests of the owner.

Q. Test all system components and connections using methods as recommended by manufacturer. Provide to architect night shots of both press box football field cameras to demonstrate proper camera tours and views using the IR floods in complete darkness. Provide similar day and night shots of traffic/license plate recognition camera.

R. Test the entire CCTV system, to include exterior cameras connected by fiber to the network. Make adjustments and retest as per Owner’s direction.

S. Provide coordination with camera call up on Hirsch alarms with 28 13 00 communications subcontractor. Fully test all camera call ups both in the school and at the police station upon panic button closures and upon other programmed Hirsch alarms.

3.3 FIELD QUALITY CONTROL

A. The specified equipment shall be supplied, installed, adjusted, tested, and guaranteed by a factory authorized communication subcontractor for the products furnished.

B. The communication subcontractor shall be responsible for verifying the completeness of the parts list and the suitability of the equipment to meet the intended purpose of the specifications and to serve the best interests of the owner.

3.4 TRAINING

A. Provide 24 hours of video surveillance training to include setting up triggers and alarms for

camera call ups in Hirsch via the integration of the video surveillance system with Hirsch and the forensic use of the recorded video, and how to maintain a chain of custody for proper recorded video use.

B. All training materials shall be provided to the owner in digital format, and all training shall be video recorded and provided to the owner on DVDs.

3.5 MANUFACTURER'S FIELD SERVICES

A. Provide manufacturer's field services for final system checkout and acceptance testing for the three systems

3.6 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

C. Seal all cameras to the exterior of the building. Seal all mounts to the exterior of the building and press box.

END OF SECTION

SECTION 310000

EARTHWORK

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Examine all drawings and all other Sections of the Specifications for the requirements therein affecting the work of this trade. Plans, surveys, measurements and dimensions, under which the work is to be performed are believed to be correct to the best of the Architect's knowledge, but the Contractor shall have examined them for himself during the bidding period, as no allowance will be made for any errors or inaccuracies that may be found herein.

B. The Contractor shall become thoroughly familiar with the site, consult records and drawings of adjacent structures and of existing utilities and their connections, and note all conditions which may influence the work of this Section.

C. By submitting a bid, the Contractor affirms that he has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of lack of full knowledge of existing conditions.

D. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure a steady progress of work under this Contract.

1.2 SCOPE OF WORK

A. Work covered by this specification includes the following but is not limited to:

1. Excavation to obtain subgrade
2. Over-excavation to remove unsuitable bearing materials
3. Proofrolling of exposed subgrade for fill, footings, foundations, slabs, walks, pavements, lawns and grasses, and exterior plants
4. Excavation for footings, foundations, structures and utilities
5. Backfilling of excavations for foundations, footings, walls, utilities, pavements, sidewalks, and landscaped areas with specified on-site and imported materials
6. Placement of bedding, sub-base and base course layers
7. Stabilization/mitigation of saturated or otherwise disturbed materials
8. Final grading
9. Excavation support, shoring or bracing as necessary
10. Required materials testing frequency

B. In order to provide a building pad suitable for the support of shallow spread footings, the geotechnical report (attached) calls for the following general construction sequence:

1. Foundation recommendations are identified in Section 3.1.2 of the “Geotechnical Report Proposed Plymouth South High School, Plymouth, MA” Prepared by LGCI, dated September 8, 2014. (attached)
2. On the western side of the proposed school building and within the proposed waste water treatment facility, where the existing fill contained organics, buried topsoil, roots, tree stumps, and other deleterious material, the existing fill shall be entirely removed to the top of the natural sand. The lateral extent of the removal of the existing fill beyond the footprint of the proposed buildings shall be governed by the influence zone of the proposed perimeter footings. The natural sand shall be proof compacted, as described herein, and the fill shall be replaced with Structural Fill within the influence zone of building areas and Ordinary Fill in paved areas. Overexcavation in this area is anticipated to extend to depths of up to 15 feet.
3. On the eastern side of the proposed school building and the proposed half time building, where there was no evidence that the existing fill contained organics, buried topsoil, roots, tree stumps, and other deleterious material, the existing fill shall be overexcavated to the top of natural sand under the influence zone of the proposed footings. The natural sand shall be proof compacted, as described herein, and the fill replaced with Structural Fill in the influence zone of building areas and Ordinary Fill in paved areas.
4. In areas underneath building slabs for the eastern half of the proposed school building, the proposed half time building, paved areas, and utility trenches, where there was no evidence that the existing fill contained organics, buried topsoil, roots, tree stumps, and other deleterious material, the existing fill shall be removed to to a depth of 1 foot below the bottom of the proposed slab, pavement section, or utility trench. The existing fill subgrade shall be proof compacted as described herein.
5. Proof compact all natural sand subgrades with a minimum of four passes of a vibratory roller compactor imparting a dynamic effort of at least 40 kips. Perform additional compaction within the influence zone of proposed footings with a dynamic vibratory compactor weighing at least 200 pounds and imparting a minimum of 4 kips. Where soft zones are revealed by compaction efforts and where organic soil is exposed, the soft material or organic soil shall be removed and replaced with Structural Fill in the influence zone of building areas and Ordinary Fill in paved areas.
6. Proof compact existing fill subgrades with at least six passes of a heavy vibratory roller compactor imparting a dynamic effort of at least 40 kips. In utility trenches, proof compact the existing fill subgrade with a minimum of four passes of a vibratory plate compactor imparting a minimum dynamic effort of 10 kips. Where soft zones are revealed by compaction efforts and where organic soil is exposed, the soft material or organic soil shall be removed and replaced with Structural Fill in the influence zone of building areas and utility trenches and Ordinary Fill in paved areas.
7. Backfill area of over-excavation to subgrade elevation in horizontal lifts placed and compacted as indicated and specified herein.
8. 12” of Structural Fill shall be placed beneath the proposed slab, and 6” shall be placed beneath proposed footings.

1.3 CONTRACT REFERENCE

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections

1. Section 01 40 00, Quality Control
2. Section 01 42 00, References
3. Section 01 50 00, Temporary Facilities
4. Section 311000 Site Preparation and Clearing
5. Section 323200 Segmental Retaining Wall
6. Section 334000 Storm Drainage Systems

1.4 DESCRIPTION

A. The Contractor shall furnish all labor, material, tools and equipment necessary to excavate materials; segregate, track, handle, sample, analyze, and test excavated materials, backfill, and re-grade as indicated on the Drawings.

B. The Contractor shall use suitable on-site soils and fill, and soil from off-site sources, as needed. ***Please note that not all on-site materials will be suitable for reuse, nor will all required material gradations be present on the site. Imported materials or blending of onsite materials with imported materials are anticipated for this project.***

C. The Contractor shall make excavations in such a manner and to such widths that will give suitable room for performing the Work and shall furnish and place all sheeting, bracing, and supports, if necessary. ***Excavation support is anticipated for this project.***

D. The Contractor shall provide labor and material for all pumping and draining, if necessary; and shall render the bottom of excavation firm and dry and in all respects acceptable. The Contractor shall collect and properly dispose of all discharge water from dewatering systems in accordance with local and State requirements and permits.

E. The Contractor shall raise the Site to final grades and compact the subgrade and intermediate layers to the required criteria set forth within the Section.

F. Routine monitoring of in-place excavation support system shall be provided.

G. Contractor shall protect and moisture condition all on site and imported materials for proper installation, compaction and use. This includes covering, drying, and adding moisture in order to maintain suitable workability of the soil materials. ***Please note onsite and imported materials will not necessarily be encountered, or delivered in a suitable condition as environmental factors prevalent at the time of construction will impact soil materials.***

H. Contractor is responsible for the legal removal and disposal of all soils within the limits of the two existing sanitary disposal fields onsite. No soils from the disposal sites will be allowed for reuse on this project.

1.5 INFORMATION

A. Information on the Drawings, Reference Drawings, Geotechnical Reports, and in the Specifications relating to subsurface conditions, natural phenomena, and existing utilities and structures is from the best sources presently available. Such information is furnished only for information and is not guaranteed.

B. Site Information – Data on indicated subsurface conditions are not intended as representations or warrants of continuity of such conditions between soil borings. It is expressly understood that Owner will not be responsible for interpretations or conclusions drawn there by the Contractor. Data is made available for the convenience of the Contractor. The Owner, Architect and Engineer assume no responsibility for the accuracy of the data other than at the particular locations and at the time the explorations were made.

C. The Contractor, at his/her own expense, may conduct additional subsurface testing for his/her own information after approval by the Owner.

1.6 SUBSURFACE CONDITIONS AND SPECIAL SITE CONSIDERATIONS

A. Soil borings and test pits have been made by qualified Contractors prior to this Contract. This information shall be made available to bidders as specified under other Sections. Procedures for dewatering, areas to receive special fill and other methods and procedures specified herein shall be supplemented by this information. For purposes of this specification, this information will be referred to as the Geotechnical Report. Where procedures within the report vary from procedures as specified herein, the specifications shall govern. The Geotechnical Report is provided elsewhere in this manual,

B. The Geotechnical Report indicates that some of the materials present at the site contain quantities of silt beyond the limit deemed acceptable for reuse by the specification. The contractor is made aware of this condition and will not be eligible to receive additional compensation for imported material exceeding the Contractor's initial bid.

C. It is the responsibility of the Contractor under this Contract to do the necessary excavation, filling, grading and rough grading to bring the existing grades to subgrade and parallel to finished grades as specified herein and as shown on the Drawings for this Work. The Contractor shall visit the site prior to submitting a bid to become familiar with the extent of the work to be done under this Contract. The Contractor shall be responsible for determining the quantities of earth materials necessary to complete the work under this Section. All earth materials shall be included in the Contractor's base bid.

D. Test boring locations as depicted on the Drawings are located by tape measurements from existing site features and structures and should only be considered as accurate as the procedure utilized.

1.7 QUALITY CONTROL

A. The Owner will retain a Soils Representative to perform on-site observations and testing during the construction operations. The service of the Soils Representative may include, but not be limited to the following:

1. Observation during excavation and dewatering of building areas, parking areas and controlled fill areas.
2. Observation during placement and compaction of fills within the building area, parking area, waste water treatment plant area, and controlled fill areas.
3. Observation, construction and performance of water content, gradation, and compaction tests at a frequency and at locations to assure conformance of this Specification. The results of these tests will be submitted to the Architect and copied to the Contractor, on a timely basis so that the Contractor can take such action as is required to remedy indicated deficiencies. During the course of construction, the Soils Representative will advise the Architect, in writing, with a copy to Contractor if, at any time, in his opinion, the work is not insubstantial conformity with the Contract Documents.

Material	Responsible Party	Situation	Test	Minimum Frequency
Structural Fill/ Ordinary Fill/ Gravel Borrow/ Common Borrow/ Bedding Material/ Crushed Stone / Pea Gravel	Contractor	Source Investigation	Grain Size through 0.002 mm Moisture Density Relationship	1 per source 1 per source
	Owner	During Placement	Grain Size through 0.002 mm Moisture Density Relationship	1 per 100 tons 1 per 100 tons
	Owner	As-Placed	Dry Density and As-Placed Moisture	2 per lift per location or activity and no less than 1 every 500 sf
Loam Borrow	Contractor	During Placement	PH, Nitrogen, Phosphorous, Potassium, and USDA Classification	2 per Acre
Riprap	Contractor	Source Investigation	Source Material Certification Specific Gravity	1 per source 1 per source
	Contractor	During Placement	Source Material Certification Specific Gravity	1 per 500 tons 1 per 500 tons

B. The Soils Representative's presence does not include supervision or direction of the actual work by the Contractor, his employees or agents. Neither the presence of the Soils Representative, nor any observations and testing performed by him, nor any notice or failure to give notice shall excuse the Contractor from defects discovered in his work.

C. The Owner reserves the right to modify or waive Soils Representative services.

1.8 PERMITS, CODES AND SAFETY REQUIREMENTS

A. This project is subject to the Safety and Health regulations of the U.S. Department of Labor set forth in 29 CFR, Part 1926. Contractors shall be familiar with the requirements of these regulations.

B. The Contractor is responsible for the adequacy of the excavation support system and shall retain the services of a Professional Engineer registered in Massachusetts to design any required excavation support systems. The Contractor's Professional Engineer shall practice in a discipline applicable to excavation work, shall have experience in the design of excavation support systems and shall design in conformance with OSHA requirements. The Contractor's Professional Engineer shall provide sufficient on-site inspection and supervision to assure that the excavation support system is installed and functions

in accordance with his design. Criteria listed herein defining the responsibilities of the Contractor's Professional Engineer are minimum requirements.

C. All work shall conform to the Drawings and Specifications and shall comply with applicable codes and regulations.

D. Comply with the rules, regulations, laws and ordinances of the Town of Plymouth, of the State of Massachusetts, appropriate agencies of the State of Massachusetts and all other authorities having jurisdiction. Coordinate all work done within Town and State rights of way with the appropriate agencies. Provide all required traffic control and safety measures, including uniformed police officers per Town and State requirements. All labor, materials, equipment and services necessary to make the work comply with such requirements shall be provided without additional cost to the Owner.

E. Comply with the provisions of the Manual of Accident Prevention in Construction of the Associated General Contractors of America, Inc., and the requirements of the Occupational Safety and Health Administration (OSHA), United States Department of Labor whichever is more stringent.

F. The Contractor shall procure and pay for all permits and licenses required for the complete work specified herein and shown on the Drawings.

G. The Contractor shall not close or obstruct any street, sidewalk, or passageway unless authorized in writing by the Architect. The Contractor shall so conduct his operations as to interfere as little as possible with the use ordinarily made of roads, driveways, sidewalks or other facilities near enough to the work to be affected hereby. The Contractor shall comply with the time limits established by the terms for trucking onto and off of the site.

H. Any apparent conflict between the Drawings and Specifications and the applicable codes and regulations shall be referred to the Architect in writing, for resolution before the work is started.

I. The Contractor shall comply with all excavation, trenching, and related sheeting and bracing requirements of Occupational Safety and Health Administration (OSHA) excavation safety standards, 29 CFR Part 1926.650 through 1926.652.

1.9 LAYOUTS AND GRADES

A. All line and grade work not presently established at the site shall be laid out by a survey team under the supervision of a Land Surveyor or Professional Engineer registered in the Commonwealth of Massachusetts and employed by the Contractor in accordance with Drawings and Specifications. Basic layout for the project is shown on the drawings. The Contractor shall supply all additional layout and grade control as necessary to properly implement and construct the work. The Contractor shall establish permanent bench marks and replace as directed any which are destroyed or disturbed.

B. The words "finished grades" as used herein shall mean final grade elevations indicated on the Drawings. Spot elevations shall govern over proposed contours. Where not otherwise indicated, project site areas outside of the building shall be given uniform slopes between points for which finished grades are indicated or between such points and existing established grades.

C. The word “subgrade” as used herein, means the surface or elevation remaining after completing excavation or top surface of a fill or backfill required surface of subsoil, borrow fill or compacted fill. This surface is immediately beneath the site improvements, fill materials as dimensioned on the Drawings, or other proposed surface material.

D. All layouts and grades shall be in accordance with Section 01 36 00 FIELD ENGINEERING.

1.10 DISPOSITION OF EXISTING UTILITIES

A. Active utilities existing on the site and work areas shall be carefully protected from damage and relocated or removed as necessitated by the work. When an active utility line is exposed during construction, its location and elevation shall be plotted on the record drawings as described in this Section and both Architect and Utility Owner notified in writing.

B. Inactive or abandoned utilities encountered during construction operations shall be removed and suitably backfilled if within the building area. Abandoned utilities outside the building area shall be removed, grouted, plugged or capped. The location of such utilities shall be noted on the record drawings and reported in writing to the Architect.

C. The Contractor shall notify “Dig Safe” and local utility companies prior to the start of construction. The “Dig Safe” number shall be submitted by the Contractor in writing to the Architect prior to construction.

1.11 SHORING AND SHEETING

A. Provide shoring sheeting and/or bracing at excavations, in order to meet the requirements of OSHA and to assure complete safety against collapse of earth at sides of excavations.

B. If, at any place, sufficient or proper supports have not been provided, additional supports shall be placed at the expense of the Contractor. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed.

C. All sheeting and bracing not ordered left in place shall be carefully removed in such a manner as not to endanger the construction of other structures, utilities or property whether public or private. All voids left after withdrawal of sheeting shall be immediately refilled with sand and rammed with tools especially adapted to that purpose or otherwise compacted as directed to achieve the required density.

D. Shoring or sheeting shall not constitute a condition for which an increase may be made in the contract price with the exception that if the Architect directs with writing that certain shoring or sheeting shall be left in place, the contract price will be adjusted in accordance with General Conditions.

E. Excavation support systems shall be designed to support the earth pressures, surcharge loads from stored material and construction equipment.

F. Shoring and bracing of trenches and other excavations shall, at a minimum, be in accordance with the latest requirements of the Department of Labor and Industries Bulletin No. 12, Section 10, and all subsequent amendments, and OSHA excavation safety standards.

G. Shoring and sheeting shall be designed by a Professional Engineer registered in the Commonwealth of Massachusetts and hired by and paid for by the Contractor.

1.12 DRAINAGE

A. The Contractor shall control the grading in areas under construction on the site so that the surface of the ground will properly slope to prevent accumulation of water in excavated areas and adjacent properties.

B. The Contractor shall excavate interceptor swales and ditches, as necessary, prior to the start of major earthmoving operations to insure minimal erosion and to keep areas as free from surface and ponded water as possible.

C. Should surface, rain or groundwater be encountered during the operations, the Contractor shall furnish and operate pumps or other equipment, and provide all necessary piping to keep all excavations clear of water at all times and shall be responsible for any damage to work or adjacent properties for such water. All piping exposed above ground surface for this use, shall be properly covered to allow foot traffic and vehicles to pass without obstruction.

D. Presence of groundwater or stormwater in soil will not constitute a condition for which an increase in the contract price may be made. Under no circumstances place concrete fill, lay piping or install appurtenances in excavation containing free water. Keep utility trenches free of water until pipe joint material has hardened and backfilled to prevent flotation.

E. For further information refer to paragraphs on SPECIAL REQUIREMENTS FOR SEQUENCE OF CONSTRUCTION OPERATIONS AND DRAINAGE AND EROSION CONTROL as specified herein.

1.13 FROST PROTECTION/WORK IN FREEZING WEATHER

A. Protect excavation bottoms and sides against freezing.

B. A layer of fill shall not be left in an uncompacted state at the close of a day's operation when there is the potential for that layer to freeze.

C. The Contractor shall not place any material on snow, ice, frozen soil, or soil that was permitted to freeze prior to compaction. Removal of these unsatisfactory materials will be at the Contractor's expense.

D. Do not excavate to full indicated depth when freezing temperatures may be expected, unless work can be completed to subgrade, the materials installed, and the excavation backfilled the same day. Protect the excavation from frost if placing of materials or backfilling is delayed.

E. The Contractor shall keep the operations under this Contract clear and free of accumulation of snow within the limits of Contract Lines as necessary to carry out the work.

F. No materials shall be installed on frozen ground.

1.14 DISTURBANCE OF EXCAVATED AND FILLED AREAS DURING CONSTRUCTION

A. The Contractor shall take the necessary steps to avoid disturbance of subgrade and underlying natural soils/compacted fill during excavation and filling operations. Methods of excavation and filling operations shall be revised as necessary to avoid disturbance of the subgrade and underlying natural soils/compacted fill, including restricting the use of certain types of construction equipment and their movement over sensitive or unstable materials. The Contractor shall coordinate with the Architect or Soils Representative to modify his operations as necessary to minimize disturbance and protect bearing soils, based on the Architect's or Soils Representative's observations.

B. All excavated or filled areas disturbed during construction, all loose or saturated soil, and other areas that will not meet compaction requirements as specified herein shall be removed and replaced with compacted Sand Gravel Fill or Crushed Stone. Fill that cannot be compacted within 48 hours because of its saturated condition shall be removed and replaced with compacted Sand Gravel Fill or Crushed Stone. Costs of removal of disturbed material and replacement with Sand Gravel Fill or Crushed Stone shall be borne by the Contractor.

C. If requested by the Architect, the Contractor shall place a six inch layer of Crushed Stone or 12 inch layer of Granular Fill over natural underlying soil to stabilize areas disturbed during construction.

1. The placement of the Crushed Stone layer or Granular Fill as well as material costs shall be borne by the Contractor.

D. Material that is above or below optimum moisture for compaction of the particular material in place as determined by the Architect or the Soils Representative and is disturbed by the Contractor during construction operations so that proper compaction cannot be reached shall be construed as unsuitable bearing materials. This material shall be removed and replaced with lean concrete, Sand Gravel Fill, or Crushed Stone as directed by the Architect or Soils Representative at no additional cost to the Owner.

1.15 SPECIAL REQUIREMENTS FOR SEQUENCE OF CONSTRUCTION OPERATIONS AND DRAINAGE AND EROSION CONTROL

A. An initial procedure for sequencing of construction operations is specified under Section 31 25 00, EROSION CONTROL. This procedure shall be extended through earthwork operations as follows:

1. Perform initial procedures as specified under Section 31 25 00, EROSION CONTROL – Initial Sequence of Construction Activities and Preliminary Drainage Control.
2. Repair any broken or damaged Sections of the haybales or siltation fencing installed during site preparation and install any additional Sections necessary for proper erosion control.
3. Throughout earthwork operations, in addition to drainage swales, check dams, siltation sumps, and other items shown on the Drawings, the Contractor shall take other necessary precautions, including installation of temporary drainage swales, siltation sumps, check dams, haybales, silt fencing and temporary

pipe to direct and control drainage from disturbed areas on the site so that erosion and siltation is minimal. In addition, no erosion or discharge of silt or larger particles shall occur in water bodies or wetland areas to remain undisturbed or onto adjacent properties.

4. Damaged or loose haybales and siltation fence shall be replaced as necessary to maintain their function of controlled erosion and siltation. Damaged or broken down check dams and filtration dams shall be replaced immediately.
5. Throughout construction, remove any accumulation of silt or soil build-up behind haybales, silt fences, check dams and filtration dams as it occurs. Remove accumulations of silt and build-up from the siltation pumps and silt traps when it is approximately 18 inches deep, or when it adversely affects the performance of the system. Remove silt sacks in catch basins when they have become clogged and replace to maintain their function.
6. Replace the crushed stone on the inside of all siltation sumps as necessary to permit adequate flow through the media and to maintain their function as a filter of silt and larger particles. Excavate silt and other material from the basins of all siltation sumps as it accumulates.
7. Remove temporary drainage swales, check dams, siltation sumps, haybales and other temporary drainage, erosion and siltation control measures when permanent drainage control measures have been installed, and grass is established in drainage areas and lawn areas. Do not remove the above items without approval of the Architect. If, in the Architect's opinion, these measures are still necessary, they shall stay in place.

1.16 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Course placed between the grade and hot-mix asphalt paving.

C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Building Area: the area defined by the projection of a line from two foot outside of the edge of the footing extending upward and outward at a slope of 1.5H: 1V. (If overexcavation is required below the footing the building area will be redefined from the bottom of overexcavation)

F. Compaction: The tamping and rolling of all backfill placed in uniform horizontal layers not exceeding a defined uncompacted lift thickness.

G. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

H. Deleterious Material: Trash, debris, clay, topsoil, roots, organic material friable, glass, or otherwise degradable materials that compromise the strength and properties of soils.

I. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated. Excavation is unclassified.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

J. Fill: Soil materials used to raise existing grades or meet proposed grades.

K. Frost Zone: The area within 4 feet of finished grade.

L. Influence Area: The area below a footing defined by the projection of a line from two foot outside of either edge of the footing extending downward and outward at a slope of 1V:1H.

M. “In-the-dry”: In-situ soil moisture content of no more than two percentage points above the optimum moisture content for that soil.

N. Optimum Moisture Content: Determined by the ASTM standard specified to determine the maximum dry density for relative compaction.

O. Prepared Ground Surface: The ground surface after clearing, grubbing, stripping, excavation, and scarification and/or compaction.

P. Proof-rolling: The tamping and rolling of all subgrades.

Q. Relative Density: As defined by ASTM D4253 or D4254.

R. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D1557. Corrections for oversized material may be applied to either the as-compacted field dry density or the maximum dry density, as determined by the Architect.

S. State Standards: Massachusetts Highway Department Standard Specifications for Highways and Bridges.

T. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

U. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

V. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

W. Unclassified Excavation: The nature of materials to be encountered has not been identified or described herein.

X. Unsuitable material: Material containing vegetation or organic material, such as mulch, peat, organic silt, topsoil, sod, deleterious material, and/or particles greater than the maximum specified diameter for that materials specific application, that are not satisfactory for use as determined by the Architect.

Y. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.17 REFERENCES

A. American Society of Testing and Materials Publications

B. Massachusetts Highway Department Standard Specifications for Highways and Bridges.

1.18 SUBMITTALS

A. Product Data: For the following:

1. Each type of plastic warning tape.
2. Geotextile.
3. Controlled low-strength material, including design mixture.

B. The Contractor shall submit under provisions of Section 01 33 00, the name of imported material suppliers. Change of source suppliers shall require approval from the Architect.

C. Grain-size distribution analysis test data shall be delivered with the samples. The analysis shall be performed in accordance with ASTM D 422.

D. The Contractor shall submit to the Architect, under provisions of Section 01 33 00, manufacturer's literature and data on proposed compaction equipment.

E. The Contractor shall provide to the Architect, on a daily basis, copies of field records documenting the location of stockpiled material, and stockpile identification data.

F. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D 2487 of each onsite and borrow soil material proposed for fill and backfill.
2. Laboratory compaction curve according to ASTM D 1557 for each on-site and borrow soil material proposed for fill and backfill.

G. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

H. Contractor shall submit designs for any required or anticipated temporary earth support and/or dewatering systems designed and stamped by a Professional Engineer registered in the Commonwealth of Massachusetts.

1.19 SAMPLING AND TESTING

A. A 50-lb. Sample of each off-site material proposed for use, and of any on-site material when so requested by the Architect or Soils Representative, shall be submitted for approval.

1. Samples shall be delivered to the office of the Architect or as directed.
2. Samples required in connection with compaction tests will be taken and transported by the Soils Representative.

B. Product Data: Submit location of pits for borrow material.

C. Samples shall be representative of the source pit. If materials are found to vary once construction begins, the Contractor will be required to submit additional representative samples at his own cost.

D. Materials imported to the site by the Contractor for on-site use shall not contain oil, hazardous waste, or deleterious materials.

1. The Contractor shall be responsible for all costs incurred by the Owner as a result of the Contractor's action to import materials containing concentrations of oil and/or hazardous materials to the site.
2. In the event that site characterization of off-site borrow sources indicates that soils are acceptable to the Architect or Engineer for use, then chemical testing will not be required. It is anticipated that chemical testing would not normally be required for material from customarily utilized commercial borrow sources.

   No fill material from "urban areas" will be accepted for fill at the site, even if chemical testing indicates no exceedances of "Reportable Concentrations".

   If requested by the Owner or Engineer, based on review of the borrow site characterization, the Contractor shall conduct testing on proposed fill material and submit results prior to delivery to the site, at no additional cost to the Owner. Testing shall be conducted by a DEP-certified testing laboratory and shall include, at a minimum, the following analytical test data.

   a. Total Petroleum Hydrocarbons (EPA Method 418.1) every 100 yards
   b. Volatile Organic Compounds (EPA Method 8420) every 500 yards
   c. PCB and Pesticides (EPA Method 8080) every 500 yards
   d. Total RCRA Metals (EPA Method 6000-7000 series) every 500 yards
   e. Polynuclear Aromatic Hydrocarbons (EPA Method 8270) every 500 yards
   f. TCLP for those total parameters which exceed twenty times the TCP criteria every 500 yards
   g. Total cyanide (EPA 9020)
3. All off-site material submitted for use on the project site shall conform to the S-1 Soils Standards contained in the Massachusetts Contingency Plan, dated October 1, 1993, Section 310 CMR 40.0975 or site soil background levels, whichever is lower. Samples will be chemically tested to determine their conformance with the S-1 Soils Standards and site soil background levels.

4. Testing parameters and testing frequencies may be reduced, as directed by the Soils Representative.
5. All sieve analyses for conformance of on-site and off-site fill materials to be used in the work shall be done by means of a mechanical wet sieve analysis and in accordance with ASTM D 422.

1.20 QUALITY ASSURANCE

A. The Engineer's duties do not include the supervision or direction of the actual work by the Contractor, his employees or agents. Neither the presence of the Engineer nor any observation and testing by the Engineer shall excuse the contractor from defects discovered in his Work at that time or subsequent to the testing.

B. Subgrades shall be approved for compactness and material composition by the Architect prior to placing subsequent lifts. If inspections indicate Work does not meet specified requirements, the Work shall be removed, replaced and compacted at no additional cost to the owner or architect.

C. Pre-excavation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

D. Contractor shall notify Architect when excavations have reached required subgrade and provide a minimum notice of 24 hours prior to placement of backfill on exposed subgrade.

1.21 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by the owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.
   1. Notify Architect not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Architect's written permission.
   3. Contact a utility-locator service for the area where Project is located before excavating.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies and Town of Plymouth to shut off services if lines are active.

C. Subsurface investigations indicated the presence of fill material which contains organic matter. This material has limited reuse applications at the site.

D. All fill to be removed from the Building Area and Influence Zone as presented on the plans and described herein.

E. Subsurface investigations indicated the presence of sandy materials which will likely be easily disturbed due to construction activities. This material is also likely to require regular moisture conditioning to obtain required compaction requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Segregate excavated material based upon material type to enable reuse in appropriate locations based upon material type.

B. Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

2.2 SOIL MATERIALS

A. Satisfactory Soils: All soil shall be ASTM D 2487 Soil Classification Group SP, SW or a combination having gradations as specified herein in the following Sections.

B. Fill material will not be accepted from off-site borrow sources that are Massachusetts DEP MCP disposal sites. Common borrow material obtained from off-site borrow sources that have no known releases or disposal of oil and/or hazardous material shall be acceptable for use only when accompanied by documentation stating there has been no known releases or disposal of oil and/or hazardous materials at the off-site borrow site.

2.3 STRUCTURAL FILL

A. Structural fill should have a plasticity index of less than 6, and should meet the gradation requirements shown below. Structural Fill should be compacted in maximum 9-inch loose lifts to at least 95 percent of the Modified Proctor maximum dry density (ASTM D1557), with moisture contents within ±2 percentage points of optimum moisture content.

Sieve Size	Percent Passing by Weight
3 inches	100
1 ½ inch	80 – 100
½ inch	50 – 100
No. 4	30 – 85
No. 20	15 – 60
No. 60	5 – 35
No. 200*	0 - 10

*0 – 5 Under sidewalks

2.4 ORDINARY FILL

A. Ordinary Fill should have a plasticity index of less than 6, and should meet the gradation requirements shown below. Ordinary Fill should be compacted in maximum 9-inch loose lifts to at least 95 percent of the Modified Proctor maximum dry density (ASTM D1557), with moisture content s within ±2 percentage points of optimum moisture content.

Sieve Size	Percent Passing by Weight
6 inches	100

1 inch	50 – 100
No. 4	20 - 100
No. 20	10 - 70
No. 60	5 – 45
No. 200	0 - 20

2.5 COMMON BORROW

A. Common Borrow material shall be soil containing no stone larger than 8 inches and shall be substantially free of organic loam, wood, trash, or other objectionable materials which may be decomposable, compressible or which cannot be properly compacted. Common Borrow materials shall not contain more than 30 percent by weight of silt and clay.

1. No Common Borrow shall be imported until available onsite Ordinary Fill has been utilized or with prior written approval from the Architect.
2. Common Borrow material from off-site borrow sources shall contain not detectable concentrations of asbestos.

2.6 GRAVEL BORROW

A. Granular Fill shall be onsite or imported material conforming to Item M1.03.0 type a or b of the State Standards.

B. Sand Gravel Fill shall be onsite or imported material conforming to Item M1.03.0 type b of the State Standards.

C. Gravel Borrow materials are not anticipated to be present onsite.

2.7 BEDDING MATERIAL

A. Gravel Borrow Bedding Material shall be imported material conforming to Item M1.03.0 type c of the State Standards.

B. Crushed Stone Bedding Material shall be imported material conforming to Item M2.01.3 of the State Standards.

C. Coarse Sand Bedding Material shall be imported material conforming to Item M1.04.0 type A of the State Standards.

D. Dense Grade Crushed Stone shall be imported material conforming to Item M2.01.7 of the State Standards.

2.8 CRUSHED STONE

A. Crushed Stone shall be impacted durable material with maximum of 1 ½ ” or 2” as specified in the Drawings. Stone used for drainage components shall be double washed. For all other applications fines shall be <1% unless otherwise noted. Crushed stone shall meet the following gradation:

Size (inches)	Percent Finer
1 ½” – 2”	100%
1 ¼”	85% - 100%
¾”	10% - 40%
½”	0% - 8%

#200	< 1%

B. 3/4" Crushed Stone shall comply with State Standards M2.01.4.

C. 1/4" to 3/8" Crushed Stone shall comply with State Standards M2.01.6.

2.9 PEA GRAVEL

A. Clean naturally rounded aggregate with particle sizes no larger than 3/4 of an inch with no more than 5% passing the #8 sieve. The dry density shall be a minimum of 95 pounds per cubic foot.

2.10 GEOTEXTILE FABRIC

A. Geotextile No. 1: Geotextile Fabric for erosion control/slope protection shall conform to Item M9.50.0 type IV of the State Standards. Geotextile No. 1 is a nonwoven geotextile composed of polypropylene fibers, which are formed into a stable network such that fibers retain their relative position. The product is inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids.

Mechanical Properties	**Test Method**	**Unit**	**Minimum Average Roll Value**
Grab Tensile Strength	ASTM D 4632-91	lbs	120
Grab Tensile Elongation	ASTM D 4632-91	%	50
Trapezoid Tear Strength	ASTM D 4533-91	lbs	50
Mullen Burst Strength	ASTM D 3786-87	psi	225
Puncture Strength	ASTM D 4833-00	lbs	65
Apparent Opening Size (AOS)	ASTM D 4751-99A	U.S. Sieve	70
Permittivity	ASTM D 4491-99A	sec^{-1}	1.8
Permeability	ASTM D 4491-99A	sec	0.21
Flow Rate	ASTM D 4491-99A	gal/min/ft	135
UV Resistance (at 500 hours)	ASTM D 4355-02	% strength retained	70

Physical Properties	**Test Method**	**Unit**	**Typical Value**
Weight	ASTM D 5261-92	oz/yd	4.8
Thickness	ASTM D 5199-01	mils	55
Roll Dimensions (width x length)	--	ft	12.5 x 360 / 15 x 360

Roll Area	--	yd	500 / 600
Estimated Roll Weight	--	lb	164 / 197

B. Geotextile No. 2: Geotextile No. 2 is a nonwoven geotextile composed of polypropylene fibers, which are formed into a stable network such that fibers retain their relative position. The product is inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids.

Mechanical Properties	**Test Method**	**Unit**	**Minimum Average Roll Value**
Grab Tensile Strength	ASTM D 4632	lbs	160
Grab Tensile Elongation	ASTM D 4632	%	50
Trapezoid Tear Strength	ASTM D 4533	lbs	60
Mullen Burst Strength	ASTM D 3786	psi	305
Puncture Strength	ASTM D 4833	lbs	95
Apparent Opening Size (AOS)	ASTM D 4751	U.S. Sieve	70
Permittivity	ASTM D 4491	sec^{-1}	1.4
Permeability	ASTM D 4491	sec	0.22
Flow Rate	ASTM D 4491	gal/min/ft	110
UV Resistance (at 500 hours)	ASTM D 4355	% strength retained	70

Physical Properties	**Test Method**	**Unit**	**Typical Value**
Weight	ASTM D 5261	oz/yd	6.4
Thickness	ASTM D 5199	mils	75
Roll Dimensions (width x length)	--	ft	15 x 300
Roll Area	--	yd	500
Estimated Roll Weight	--	lb	217

C. Geotextile No. 3: Geotextile for the installation of underground tank

1. Woven geotextile fabric with a minimum grab tensile strength of 120 lbs/inch and a maximum apparent opening size of #50 US sieve (0.300 mm)

2.11 OTHER SOIL MATERIAL

A. Drainage Aggregate: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.

B. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch (25-mm) sieve and 0 to 5 percent passing a No. 4 (4.75-mm) sieve.

C. Fine Aggregate: ASTM C 33; fine aggregate, natural, or manufactured sand.

D. River Stone: River stone shall be 1 ½" – 3" rounded, smooth stone, color shall be tan-beige range. Contractor to submit 5 gallon container sample with source indicated.

E. Rip-rap: rip-rap shall be sound, durable rock which is angular in shape in accordance with M2.02.0 of the State Specifications.

2.12 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; colored as follows:

B. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 – EXECUTION

3.1 GENERAL

A. Prior to commencing work, the Contractor shall establish property line locations and place construction control markers clearly visible and understandable to workers in the field. The Contractor shall exercise due care so as not to disturb adjacent structures and shall leave the Site in clean and orderly condition upon completion of the work.

B. Unanticipated Soil Conditions:

1. If unsuitable bearing materials are encountered at the specified subgrade depths, the Contractor shall notify the Architect. The Contractor shall carry

excavation deeper and replace the excavated material with compacted fill or concrete as directed by the Architect or Soils Representative.

2. Removal of such material and its replacement as directed will be paid an extra compensation in quantity approved by the Architect. Only changes in the work authorize in advance by the Architect in writing shall constitute an adjustment in the Contract Price.
3. Material that is above or below optimum moisture for compaction of the particular material in place as determined by the Architect or the Soils Representative and is disturbed by the Contractor during construction operations so that proper compaction cannot be reached shall not be construed as unsuitable bearing materials. This material shall be removed and replaced with lean concrete or compacted Gravel Borrow as directed by the Architect or Soils Representative at no additional cost to the Owner.
4. The Contractor shall follow a construction procedure which permits visual identification of firm natural ground.

C. Excessive Excavation: If any part of the general or trench excavation is carried, through error, beyond the depth and dimensions indicated on the Drawings or called for in the Specifications, the Contractor at his own expense, shall furnish and install compacted gravel fill, concrete, or take other remedial measures as directed by the Architect to bring fill material up to the required level or dimension.

D. Reuse of onsite material: Not all of the materials onsite will be suitable for reuse in all areas of the site. Imported materials are anticipated to meet all of the materials required as described above.

1. Samples and Testing:
2. Excavated material taken directly from on-site cuts that will meet the Specifications may be used as fill provided the Contractor obtains written approval from the Architect. No such fill material shall be put in place until approved for use by the Architect in writing. Sand Gravel Fill is not anticipated to be found on the site.
3. Testing of materials as delivered may be made from time to time. Materials in question may not be used, pending test results. Tests of compacted materials will be made regularly. Remove rejected materials and replace with new, whether in stockpiles or in place.

E. Deficiency of Fill Material: Provide required additional fill material to complete the work if a sufficient quantity of suitable material is not available from the required excavation on the project site at no additional cost to the Owner.

F. Surplus Fill Material: Surplus fill that is not required to fulfill the requirements of the Contract shall be removed from the site and legally disposed of.

3.2 PREPARATION

A. The Contractor shall be deemed to have inspected the Site and satisfied himself/herself as to actual grades and levels and true conditions under which the Work will be performed.

B. Areas required for execution of Work shall be cleared. The work area shall be free of standing water and shall be dry.

C. All site health and safety controls shall be fully established and in operation prior to beginning any demolition, soil, and fill excavation. Site controls shall include but not be limited to work zones properly barricaded, wheel wash and decontamination facilities, and all support equipment and supplies including personal protective equipment. All site controls shall be reviewed by the Architect in the field.

D. The Contractor shall provide all layout field data, including ties, to the Architect. The Contractor shall maintain all required field controls throughout the performance of the Work.

E. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

F. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Section 31 10 00 Site and Preparation Clearing."

G. Protect and maintain erosion and sedimentation controls, which are specified in Division 31 Section 31 10 00," during earthwork operations.

H. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

3.3 BUILDING PAD PREPARATION

A. Contractor shall excavate from within the Building Area and Influence Area all unsuitable soils to a depth sufficient to reach the native soils as specified herein, within the geotechnical report, and within the contract plans. Note this may require excavation below footing subgrade as specified herein, within the geotechnical report, and within the contract plans

B. All excavated materials shall be segregated such that reusable material meeting the gradations provided for above are separated from organics and all other deleterious material.

C. Once the final subgrade has been reached, and upon acceptance by the Architect and Soils Representative, Contractor shall backfill the excavated area with Structural Fill in the influence zone of building areas and Ordinary Fill in paved areas. Excavation is anticipated to extend up to 15’ in the western portion of the building. Limits of excavation shall be determined in the field based upon observed conditions.

D. Structural Fill shall be placed within 1 foot of the bottom of all footings and slabs as structural bedding. NOTE: NOT ALL EXCAVATED MATERIAL WILL MEET THE GRADATIONS FOR GRANULAR FILL AND STRUCTURAL FILL.

3.4 PROOF COMPACTING

A. Areas requiring excavation shall be excavated to subgrade and then proof compacted as specified in Section 1.2 of this Specification Section.

B. Where soft zones are revealed by compaction efforts and where organic soil is exposed, the soft material or organic soil shall be removed and replaced with

Structural Fill in the influence zone of building areas and utility trenches and Ordinary Fill in paved areas.

3.5 EXCAVATION, GENERAL

A. The Contractor shall remain responsible for adequacy and safety of construction means, methods and techniques.

B. The Contractor shall complete all excavations regardless of the type, nature or condition of the material encountered. The Contractor shall be solely responsible for making all excavations in a safe manner.

C. The Architect shall be notified of unexpected subsurface conditions. Work shall be discontinued in affected areas until notified to resume work by the Architect.

D. Displaced or loose soil shall be prevented from falling into any excavation. The stability of soil slopes shall be maintained in accordance with applicable local, state and federal regulations and guidelines.

E. All loose material shall be removed from the bottom of the excavation so that the bottom shall be in an undisturbed condition. If removal of the loose material results in excavation beyond the work limits and over excavation has not been approved by the Architect; the restoration of the excavation to grade shall be done at no additional cost to the Architect.

F. When the bottom of the excavation shall, by error of the Contractor, have been taken to a depth greater than the depth specified, or directed by the Architect, said condition shall be corrected by refilling to the proper grade with granular fill or the design shall be altered in a fashion acceptable to the Architect to compensate for said error. All measures taken to rectify conditions caused by over excavation shall have the Architect's approval, and any increase in cost resulting from such measures shall be borne by the Contractor.

G. Excavation shall not be performed when weather conditions or the conditions of the materials are such that, in the opinion of the Architect, work cannot be performed satisfactorily.

H. Appropriate measures shall be provided to retain excavation sidewalls and to ensure that persons working in or near the excavation are protected. Sheeting shoring or bracing may be used to support the walls of excavations. Method, design, construction and adequacy of any required bracing shall meet the OSHA requirements of 29 CFR Part 1926 and are the responsibility of the Contractor.

I. All damage related to or caused by the excavation shall be repaired at the expense of the Contractor.

J. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

a. 6 inches beneath pipe in trenches, and

b. The greater of 18 inches wider than pipe or 36 inches wide.

K. The Contractor shall excavate soil and fill to the limits necessary to achieve the required grades determined by the Architect. The limits of excavation may not coincide with those areas indicated on the Drawings. The excavation areas shown on the Drawings are estimated areas only.

L. If unanticipated bearing soils are encountered beyond the limits of excavation as specified on the Drawings and in the Specifications and at the specified subgrade depth, the Contractor shall notify the Owner's Representative in writing. The Contractor shall carry the excavation deeper and replace the excavated material with appropriate specified material or concrete as directed by the Architect or Engineer.

M. Removal of topsoil, subsoil, rock, boulder, and organic silt, or silty sand as specified herein and in the Geotechnical Report will not be considered as unanticipated, unsuitable soil conditions at an elevation above specified subgrade elevations. Similarly removal of these materials within paved areas as specified herein will not be considered unanticipated unsuitable soil conditions. Proposed overexcavation as shown on the plans will not be considered unanticipated soil conditions.

N. Unsuitable Soil Allowance: The Contractor shall carry in the base bid 1000 cu. yds. for removal of unanticipated, unsuitable soil materials beyond the subgrade limits shown on all contract drawings and defined within the specification and beyond the quantity required for overexcavation as shown on the plans and defined within the specifications. Allowance shall cover removal and disposal of unsuitable soil and furnishing imported suitable backfill materials compacted in place as directed herein. The base bid shall cover all costs related to such excavation, removal off site, disposal, and replacement with compacted fill of approved material, overhead, and profit. No amount other than that herein specified will be paid by the Owner for excavated defined herein.

1. If the total void volume of unanticipated unsuitable material excavation below specified subgrades, and its replacement with compacted fill exceeds the amount included in the Contract as listed above, the Owner shall pay the excess excavation and replacement at the unit price of $35.00 per cubic yard.
2. If the total quantity of unanticipated unsuitable materials below specified subgrades, and its replacement with compacted fill is less than the amount included in the Contract as listed above, the contract sum will be decreased by the difference in excavation and its replacement multiplied by the unit price of $30.00 per cubic yard.
3. Final excavated surfaces shall be surveyed by the Contractor and shall be measured from specified subgrade to bottom of excavation. Payment shall be based upon actual volumes with no bulking or swell factors applied. Contractor shall submit all survey data and quantity calculations to Architect for approval.

3.6 ROCK EXCAVATION

A. Definitions and Classifications: The following classifications of excavation will be made only when rock excavation is required.

1. “Earth Excavation” consists of removal and disposal of pavement and other obstructions visible on ground surface, underground structures and utilities indicated to be demolished and removed, material of any classification indicated in data on subsurface conditions, and other materials encountered that are not classified as rock excavation.
2. “Rock Excavation” consists of removal and disposal of materials encountered that cannot be excavated without continuous and systematic drilling and blasting or continuous use of a ripper or other special equipment, except such materials that are classed as earth excavation. Typical of materials classified as rock excavation are as follows:
   a. Rock or stone in original ledge.
   b. Hard shale in original ledge.
   c. Boulders on site, outside trench limits, exceeding three cubic yards in volume.
   d. Boulders within trench limits, exceeding one cubic yard in volume.
3. Should highly fractured or weathered bedrock be encountered during excavation, the following shall apply:
   a. When the material is encountered in trenching operations or under footings, it shall be excavated or ripped with a hydraulic backhoe equal to or larger than Caterpillar 225 backhoe, and will be classified as Earth Excavation. When it is demonstrated to the satisfaction of the Architect and the Soils Representative that this material can no longer be removed with a hydraulic backhoe and requires drilling and blasting, this material shall be classified as Rock Excavation. For excavation procedures when this material is encountered under footings, refer to paragraph below.
   b. When this material is encountered in open excavation, it shall be classified as earth excavation until drilling and blasting or continuous ripping is necessary as defined hereinabove.
4. Intermittent drilling and ripping performed to increase production and not necessary to permit excavation of material encountered will be classified as earth excavation.
5. Allowance for Rock Excavation: The Contractor shall carry in the Base Bid an allowance for 10 cubic yards or rock encountered in trench excavation removed from the site. The Contractor shall also carry in the Base Bid an allowance of 10 cubic yards of open rock excavation removed from the site. The Base Bid shall cover all costs relating to such rock excavation, including blasting, removal and placement of the excavated material, overhead and profit. No amount other than that herein specified will be paid by the Owner for excavation herein defined.
   a. If the total quantity of Rock Excavation, open and/or trench, exceeds the amount of Rock Excavation included in the Contract as listed above, the Owner shall pay the excess excavation at the unit price submitted in the Bid Form.
   b. If the total quantity of Rock Excavation, open and/or trench, is less than the amount of Rock Excavation included in the Contract as listed above, the Contract sum will be decreased by the difference in Rock Excavation multiplied by the unit price submitted in the Bid Form.

B. Measurements:

1. When, during the process of excavation, rock is encountered, such material shall be uncovered and exposed in such a manner that the unbroken ledge surface is clearly visible, and the Architect shall be notified by the Contractor, before proceeding further. The areas in question shall then be cross-sectioned as hereinafter specified.
2. Failure on the part of the Contractor to uncover such material and to notify the Architect and proceeding by the Contractor with the rock excavation before cross-sections are taken, will forfeit the Contractor's right of claim towards the stated allowance or additional payment over and above the stated allowance at the quoted unit price.
3. The Contractor shall employ and pay for a Professional Civil Engineer or Land Surveyor registered in the Commonwealth of Massachusetts to take cross-sections of rock before removal and to make computations of volume of rock encountered within the Payment Lines. Cross-sections shall be taken in the presence of the Soils Representative and the computations approved by the Architect. The Owner has the option to perform independent cross-sections and computation of rock quantities.
4. Where removal of boulder or ledge is required outside the established payment lines, the extent of this removal and basis of payment shall be determined by the Architect.

C. If ledge is encountered within the limits of the Proposed Building Area, the Contractor shall excavate this material 18 inches below subgrade of footings and 12 inches below subgrade of slabs unless otherwise directed by the Architect or Soils Representative. All loose or shaken rock shall be removed and replaced with compacted gravel fill, crushed stone or lean concrete as directed by the Soils Representative.

D. Rock excavation for foundations outside of the Building Area: Remove rock to foundation or footing subgrade. All rock bottoms for foundations shall be carefully examined. Loose or shaken rock shall be removed to solid bearing, and the rock surface leveled, or shelved to a slope not exceeding one inch per two feet, or as directed.

E. Excavate rock encountered in grading under paved areas, lawns and plant beds to subgrade as specified herein and shown on the Drawings. All boulders or protruding rock outcrops shall remain undisturbed at lawns and plant beds when so directed by the Architect. Rock shall be fractured six inches below subgrade of paved areas but this six-inch layer shall remain in place. Rock in lawns and plant beds shall be similarly treated unless it is directed to remain.

F. Prepared rock subgrades shall be compacted with at least four passes of a self-propelled vibratory roller such as Dyna Pac CA-30D (44,000 lbs. Centrifugal force) or equivalent. Rock subgrades in utility trenches shall be recompacted with at least four passes a walk-behind vibratory drum roller or other equivalent equipment having at least 10,000 pounds centrifugal force and sufficient to provide a firm, stable subgrade.

G. If any part of the rock excavation at footings to be carried beyond the depth and the dimensions indicated on the Drawings or called for in the Specifications, the Contractor shall, at his own expense, furnish and install concrete of same strength

as footings to the required subgrade level of the footings as shown on the Drawings. Dowelling or other corrective structural measures as directed by the Architect may also be required to properly anchor or reinforce the concrete. If rock excavation is carried beyond the depth and dimensions to subgrade in other areas, the Contractor shall, at his own expense, furnish and install compacted gravel fill to subgrade as directed by the Architect.

H. Basis of Payment: The total amount of rock excavation will be based upon the in-situ volume of rock excavated within and/or above the lines referred to in the next paragraph as “Payment Lines”. The payment lines are only to be used as a basis of payment, and are not to be used as limits of excavation. Limits of excavation area as shown on the Drawings and as specified herein.

I. Payment Lines for Rock Excavation:

1. Payment lines for columns and footings within the building shall be a vertical line one-foot off the edge of the footings; the depth shall be measured at 24 inches below the bottom elevations shown on the Drawings. If rock is to remain directly below the bottom of the footings within the Building Area, payment lines shall be six inches below the bottom elevation of the footing as shown on the Drawings. Payment lines for walls to be damp-proofed shall be a vertical line two feet outside the walls. Payment lines for footings outside of the building shall be six inches below the bottom of footings. Vertical payment lines shall be as specified hereinafter.
2. Payment lines for manholes and catch basins shall be one-foot outside of the outer wall and six inches below subgrade beneath the structure.
3. Payment lines for rock excavation under slabs on grade shall be six inches below the bottom elevation of the specified gravel base course outside of the building and 12 inches below subgrade for slabs within the building. Payment lines for rock excavation at plant beds shall be 12” at edge and full depth of required elevation for loam.
4. Payment lines for rock excavation at paved areas and lawns shall be six inches below respective subgrades.
5. Payment lines for rock excavation under pipes within the building and for utility trenches outside the building lines shall in no case be calculated as greater in width than the outside diameter of the pipe plus two feet for pipes up to 18 inches. For pipes 18 inches and larger payment lines shall in no case be calculated as greater in width than the outside diameter of the pipe plus three feet. Payment lines at bottom of all pipe and utility trenches shall be six inches below subgrade.

3.7 STORAGE OF SOIL MATERIALS - STOCKPILING

A. The Contractor shall be responsible for managing and tracking any and all materials excavated and placed in stockpiles for testing.

B. Materials shall be stockpiled on site at locations proposed by the Contractor and approved by the Architect. Stockpiled materials shall be of sufficient quantities to meet project schedule and requirements

C. Tracking of the stockpiles shall be performed in accordance with the approved Work Plan submitted by the Contract in accordance with Section 01 33 00.

D. The temporary stockpiled fill must be removed from the Site in accordance with applicable regulatory deadlines however no later than the completion date of this contract or 90 days from the date the stockpile was created, whichever is encountered first.

E. Stockpiles shall be securely barricaded and clearly labeled. Differing materials shall be separated with dividers or stockpiled apart to prevent mixing.

F. The Contractor shall direct surface water away from stockpile site to prevent erosion or deterioration of materials. Soils shall be suitably dewatered prior to their relocation on Site or disposal off site.

G. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.8 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.9 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Trenches shall be excavated to the necessary width and depth for proper laying of pipe or other utility and excavation side slopes shall conform to OSHA requirements. Minimum width of trenches shall provide clearance between the sides of the trench and the outside face of the utility. Maximum trench sizes are as shown on the Drawings or as specified herein. The depth of the trench shall be six inches below the bottom of the pipe barrel or respective utility. If the existing soil at the final subgrade excavation is found not suitable, the Architect or Soils Representative may approve removal and replacement of material.

1. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit, unless otherwise indicated.
2. Clearance: As indicated on plans.
3. For pipes and conduit 6 inches (150 mm) or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.
4. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

C. The Contractor shall provide, at his own expense, suitable bridges over trenches where required for accommodation and safety of the traveling public and as necessary to satisfy the required permits and codes.

3.10 SUBGRADE INSPECTION, COMPACTION AND PROOF ROLLING

A. Notify Architect when excavations have reached required subgrade.

B. Proof compact all subgrades in accordance with Subsection 1.2 of this Specification Section and the Geotechnical Report to identify soft pockets and areas of excess yielding. Do not proof compact wet or saturated subgrades.

1. Completely proof compact subgrade in one direction repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect and/or Soil Representative, and replace with compacted fill as directed.
3. Proof compacting shall be completed utilizing a 20-Ton vibratory drum roller for granular soils. Should clay or other cohesive soils be encountered, sheep's foot roller shall be utilized. A total of 6 passes shall be considered complete.

C. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect and/or soil representative, without additional compensation.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage,
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.

B. If, through failure or neglect of the Contractor to conduct the excavation work in a proper manner, the surface of the subgrade is in an unsuitable condition for proceeding with construction, the Contractor shall, at his own expense, remove the unsuitable material and replace it. Failure of the Contractor to control surface or ground water adequately, premature excavation at the work site, or other manifestations of the Contractor's neglect or improper conduct of the work, as determined by the Architect, shall be grounds for requiring removal and replacement of unsuitable subgrade without additional compensation.

C. Grading in the vicinity of backfilling shall be properly pitched to prevent water from running into the backfilled area. Work areas shall be kept free from water during performance of the work under this Contract at no expense to the Architect. The Contractor shall build diversion berms and other devices necessary for this purpose.

D. The Contractor shall not commence backfilling operations until the Architect gives approval.

E. After the subgrade has been prepared, fill material shall be placed and built-up in successive layers until the required elevations are reached. No fill shall be placed on a frozen surface, nor shall snow, ice, or other frozen material be included in fill. Wet materials containing moisture in excess of the amount necessary for satisfactory placement or compaction shall not be used.

F. All fill shall be brought up in essentially level lifts and shall be placed in levels by standard methods. The method of placement shall not disturb or damage other work. Layers of fill shall not exceed twelve inches of uncompacted thickness before compaction, unless otherwise specified or as necessary for proper subgrade stabilization.

G. Place backfill on subgrades free of mud, frost, snow, or ice.

H. Filling operations shall continue until the fill has been brought up to the finished slopes, lines, and grades making proper allowances for thickness of surface treatment.

I. The entire surface of the work shall be maintained free from ruts and in a condition that will permit construction equipment to travel readily over any Section. The top surface of each layer shall be made level or slightly sloped away from the center of the filled area. Fills should be graded to drain and compacted/sealed whenever precipitation is expected.

J. Backfilling shall not be performed when weather conditions or the conditions of the material are such that, in the opinion of the Architect, work cannot be performed satisfactorily.

3.12 ACCEPTABLE BACKFILL MATERIALS

A. Backfill materials shall be placed in the areas as indicated in the table below:

Fill at depths greater than 1-foot below footings and slabs within the Building Area	Structural Fill (Geotech Report)
Fill around footings for building and structures within the Influence Area	Structural Fill (Geotech Report)
Fill below pavement subgrade elevation	Ordinary Fill (Geotech Report)
Fill below sidewalk subgrade elevation	Ordinary Fill (Geotech Report)
Fill within utility trenches below pavement and sidewalk subgrade	Granular Fill
Fill below utility bedding	Granular Fill
Fill placed 6 inches below footings	Structural Fill (Geotech Report)
Fill placed 1 foot below slabs	Structural Fill (Geotech Report)
Fill placed in landscaped areas outside of the Influence Area	Common Borrow

3.13 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Place and compact initial backfill material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

D. Backfill voids with satisfactory soil while installing and removing shoring and bracing.

E. Place and compact final backfill of satisfactory soil to final subgrade elevation.

F. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.14 BELOW GRADE TANK BACKFILL

A. Backfill with Pea Gravel as specified in paragraph 2.9 of this section. The manufacturer has indicated that the use of the proper material is critical to the long term tank performance.

B. Do not mix approved backfill material with sand or native materials. Do not backfill tank with sand or native materials.

C. Replace all excavated native materials with approved Pea Gravel which meets ASTM C 33 for quality and soundness.

3.15 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

1. Sequentially place and compact fill material in layers to required elevations.

B. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.16 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by +2 to -3 percent and is too wet to compact to specified dry unit weight.

3. If in the opinion of the Architect, additional moisture is required, water shall be applied by sprinkler tanks or other uniform distribution devises. If excessive amounts of water or if rain should cause excessive wetness, the area shall be allowed to dry as provided above.

3.17 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross Sections, lines, and elevations indicated. Grading shall be done by standard methods. Areas adjacent to structures and other areas inaccessible to heavy grading equipment shall be graded by manual methods. Embankments shall be graded at all times to ensure runoff of water.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
3. Provide proper drainage from the site, no grading shall be done to direct water to damage or potentially damage adjacent property or work executed under this contract.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Lawn or Unpaved Areas: Plus or minus [**1 inch**]
2. Walks: Plus or minus [**1 inch**]
3. Pavements: Plus or minus [**1/2 inch**]

3.18 FIELD QUALITY CONTROL

A. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

B. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed in accordance with Subsection 1.7 of this Specification Section and:

1. Paved Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every **500 sq. ft.** or less of paved area, but in no case fewer than 3 tests.
2. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for each **150 feet** or less of trench length, but no fewer than 2 tests.

C. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.19 COMPACTION REQUIREMENTS

A. The following table lists minimum compactive efforts, which are required for all, fill materials. Compaction of each lift shall be completed before placement and compaction of the next lift is started. The compaction equipment shall make an equal numbers of transverse and longitudinal coverages of each lift. The degree of compaction for fill placed in various areas shall be as follows:

1. Under concrete slabs and footings 95%
2. In paved areas

Within aggregate base course	95%
Within aggregate subbase course	95%
Below subbase course	92%
3. In landscaped areas	90%
4. Around and Above Utilities below	
Below Pavement subbase in paved areas	92%

*Percentage of maximum dry density of the materials at optimum moisture content as determined by methods or tests for ASTM designation D1551 Method D.

B. Compaction shall be accomplished by vibratory rollers, multiple wheel pneumatic tired rollers or other types of approved compacting equipment. Loaded trucks, low beds, water wagons and the like shall not be considered as acceptable compaction equipment unless specifically approved by the Architect for a particular location. Equipment shall be of any such design that it will be able to compact the fill to the specified density in a reasonable length of time. All compaction equipment shall be subject to the approval of the Architect.

C. The Contractor shall compact all fills made during the day of work prior to leaving the project for the evening. The upper layer shall be pitched as necessary to provide positive drainage towards swales or interceptor ditches to minimize ponding and erosion should it rain.

3.20 COMPACTION TESTING

A. The Contractor shall make all necessary excavations and preparations for testing. Excavations for density tests shall be backfilled with material similar to that excavated, and compacted to the specified density by the Contractor. Failure of the backfill material to achieve the specified density will be just cause for rejection of any or all portions of the excavation Section tested. The Contractor will not be granted an extension of time or additional compensation for testing or repair of backfill ordered by the Architect.

B. Field density tests will be made by the Owner's Inspection Agency in accordance with the Method of Test for ASTM Designation D1556 or D6938, to determine adequacy of compaction; the location and frequency of such field tests shall be at the Architect's Inspection Agency's discretion.

C. All field density tests results shall be reviewed by the Architect prior to the placement of concrete.

D. The Contractor shall notify the Inspection Agency when an area is ready for compaction testing. This notification shall be 48 hours in advance of placing or final compaction so that the Architect Inspection Agency has adequate time to take compaction tests.

E. Cooperate with the Architect in obtaining field samples of in-place materials after compaction. Furnish incidental field labor in connection with these tests. The Contractor will be informed by the Architect of areas of unsatisfactory density which may require improvements by removal and replacement, or by scarifying, aerating, sprinkling (as needed), and recompaction prior to the placement of the new lift. No additional compensation shall be paid for work required to achieve proper compaction.

F. The Owner or Architect's Inspection Agency's presence does not include supervision or direction of the actual work by the Contractor, his employees, or agents. Neither the presence of the Inspection Agency nor any observations and testing performed by him shall excuse the Contractor from defects discovered in his work.

3.21 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

1. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

B. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

1. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
2. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Project property.

3.23 REMOVAL OF EROSION CONTROL MEASURES

A. Remove temporary drainage swales, check dams, siltation sumps, hay bales, siltation fencing and other temporary drainage, erosion and siltation control measures when permanent drainage control measures have been installed and grass is established in drainage areas leading to siltation sumps. Contractor shall excavate and remove all sediments from siltation sumps prior to backfilling the sumps. Remove erosion control measures when approved by the Architect.

End of Section

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Section 311000

SITE PREPARATION AND CLEARING

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS, which are hereby, made a part of this Section of the Specifications.

B. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this trade.

C. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

1.2 SCOPE OF WORK

A. This Section includes the following but is not limited to:

1. Removing existing trees, shrubs, groundcovers, plants and grass.
2. Clearing and grubbing.
3. Stripping and stockpiling topsoil.
4. Removing above- and below-grade site improvements.
5. Installation and maintenance of temporary erosion and sedimentation control measures.
6. Removal and disposal of site features at the locations specified on the Drawings and in Section 02 41 00 Site Demolition.

B. Work to be done includes furnishing all labor, materials, equipment and services required to complete all site preparation, erosion control and demolition work indicated on the drawings and as specified herein.

C. Special attention is directed to requirements covering existing site conditions to be protected and preserved in the finished work and to the Initial Sequence of Construction Activities and Preliminary Drainage Control specified herein.

D. It is brought to the Contractor's attention that procedures for drainage, erosion and siltation control specified in this Section and Section 31 25 00 will be controlled by a NPDES General Permit for Construction Activity. The Contractor is responsible for filing the NPDES General Permit for Construction Activity. A copy of Notice of Intent and NOI drawings shall be retained on the site during construction. In addition to this Section, the Contractor shall refer to the General and Supplemental General Conditions and Division 1, General Requirements, for other conditions related to the NPDES Permit. Contractor is required to prepare all necessary documents required for the NPDES Permit including Storm Water Pollution Prevention Plan.

F. Applying for and obtaining an NPDES Permit for General Construction Activity prior to any construction work at the site is the Contractor's responsibility.

1.3 RELATED WORK

A. Division 2 – Section 02 41 00 – Site Demolition.

B. Division 31 – Section 31 00 00 Earthwork for soil materials, excavating, backfilling, and site grading.

C. Division 31 – Section 31 25 00 “Erosion Control” for installation and maintenance of erosion controls, minimization of disturbances to sensitive areas.

D. Division 32 – Section 32 00 00 Bituminous Concrete Paving, Curbing and Edging for placement of vertical granite curing and paving of roadways and walkways.

1.4 LIABILITY FOR DAMAGES

A. The Contractor shall be liable for all damage and/or disturbance to existing adjacent lands beyond the Limit of Work. Actual damage to these areas, caused by the Contractor, shall be repaired to the satisfaction of the Architect, at no additional cost to the owner or architect. Repairs may include pruning or removing damaged vegetation as specified, replacement of damaged vegetation, restoration of the ground plane to its original condition, and any other work required to restore the area to its original condition as depicted in the site photographs taken at the beginning of construction. The project will not be accepted until all repair work is complete.

1.5 PERMITS AND CODES

A. All work shall comply with all codes, rules, regulations, laws and ordinances of the Town of Plymouth, Commonwealth of Massachusetts, and all other authorities having jurisdiction. All work necessary to make site preparation comply with such requirements shall be provided without additional cost to the Owner.

B. The Contractor shall procure and pay for all permits and licenses required for work under this Section.

C. The Contractor shall not close or obstruct any streets, sidewalks, or passageways, unless and until they have been discontinued by the Town or unless and until he shall have first secured all necessary municipal or other permits thereof. No material whatsoever shall be placed or stored in streets or passageways until they have been so discontinued. The Contractor shall conduct their operations to interfere as little as possible with the use ordinarily made of roads, driveways, sidewalks, or other facilities near enough to the work to be affected thereby.

D. The procedures for drainage, erosion, and siltation control specified in this Section and Section 312500, are related to procedures required for a NPDES General Permit NOI. In addition to these Sections, the Contractor shall refer to the General and Supplementary General Conditions and Division 1 General Requirements for other conditions related to the NPDES Permit.

E. Issue submittals in accordance with Division 1. Submittals under this Section shall include manufacturer’s specifications and installation instructions.

1.6 EXAMINATION OF SITE AND DOCUMENTS

A. It is hereby understood that the Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of lack of full knowledge of existing conditions.

B. Plans, surveys, measurements and dimensions, under which the work is to be performed are believed to be correct to the best of the Architect's knowledge, but the Contractor shall have examined them for himself during the bidding period, as no allowance will be made for any errors or inaccuracies that may be found herein.

C. Information on the Drawings, Reference Drawings, and in the Specifications relating to subsurface conditions, natural phenomena, and existing utilities and structures is from the best sources presently available. Such information is furnished only for the information and convenience of the Contractor, and the accuracy or completeness of this information is not guaranteed.

D. Site Information – data on indicated subsurface conditions are not intended as representations or warrants of continuity of such conditions between soil borings. It is expressly understood that Owner will not be responsible for interpretations or conclusions drawn there from by the Contractor. Data are made available for the convenience of the Contractor. Neither the Owner nor the Soils Representative assumes responsibility for accuracy of the data other than at the particular locations and at the time the explorations were made.

1.7 STAGING AREA

A. No parking is permitted within the right of way of adjacent streets or onsite outside of the limit of work for each phase. The Contractor shall submit a plan for his/her construction staging and equipment storage within the limits of work, prior to commencing construction.

B. No parking of cars or stockpiling of construction materials shall be permitted under any trees that are scheduled to remain or be protected.

1.8 DISPOSITION OF EXISTING UTILITIES

A. Active utilities existing on the site shall be carefully protected from damage and relocated or removed or abandoned as necessitated by the work. When an active utility line is exposed during construction, its location and elevation shall be plotted on the record drawings as described in this Section and both Architect and the utility owner notified in writing.

B. Inactive or abandoned utilities encountered during construction operations shall be removed, plugged or capped. The location of such utilities shall be noted on the record drawings and reported in writing to the Architect.

PART 2 – PRODUCTS

2.1 TREE PROTECTION FENCING

A. Fencing fixed in position and meeting the following requirements:

1. Plastic Protection-Zone Fencing: Plastic construction fencing constructed of high-density extruded and stretched polyethylene fabric with 2-inch (50-mm) maximum opening in pattern and weighing a minimum of 0.4 lb/ft. (0.6 kg/m); remaining flexible from minus 60 to plus 200 deg F (minus 16 to plus 93 deg C); inert to most chemicals and acids; minimum tensile yield strength of 2000 psi (13.8 MPa) and ultimate tensile strength of 2680 psi (18.5 MPa); secured with plastic bands or galvanized-steel or stainless-steel wire ties; and supported by tubular or T-shape galvanized-steel posts spaced not more than 8 feet (2.4 m) apart.
   a. Height: 4 feet
   b. Color: High-visibility orange, nonfading.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Restrict construction activities to those areas within the limits of construction, public rights-of –way, and easements designated on the Contract Drawings. Adjacent properties and improvements thereon, public or private, which become damaged by construction operations shall be promptly restored at the Contractor's expense to their original condition, and to the full satisfaction of the property owner.

3.2 SITE CLEARING

A. General: Remove trees, shrubs, grass and other vegetation, improvements, or obstructions, except for those indicated on the Contract Drawings to remain, interfering with installation of new construction. Remove such items elsewhere on site or premises as specifically indicated. Removal shall include digging out stumps in their entirety and grubbing roots to at least 30 inches below existing or proposed grades, whichever is deeper, as shown on the Contract Drawings.

B. Carefully and cleanly cut roots and branches of existing trees indicated to remain and be protected, where such roots and branches obstruct new construction. Use only hand methods for grubbing inside drip line of trees indicated to be left standing.

C. Clearing shall consist of the felling and disposal of standing trees, and the removal and disposal of all brush, down timber, fences and rubbish. Trees, brush and down timber may be chipped and a portion of the chipped material shall be stockpiled on site in a location selected by the Architect and for dispersion into wooded areas in locations selected by Architect.

D. In all areas that are to be cleared, all brush, grass and other vegetation, except trees, shall be cut off flush with or below the original ground surface.

E. All lines and grade work required for this contract at the site shall be laid out by a registered land surveyor or Professional Engineer employed by the Contractor, in accordance with the Drawings and Specifications.

F. Prior to starting site clearing operations, stake out all roads, edges of parking areas, and other future paved areas as indicated, limits of cut and fill at the edges of

these areas (it limits do not coincide) and areas of trees to be saved as noted on the Drawings.

G. Before any clearing is done, promptly upon completion of layout work, the Contractor shall arrange a conference on the site with the Architect to identify and mark trees and shrubs which are to remain. Adjustments to clearing lines shall be made at this time to save trees or other existing conditions on the edges of clearing lines. If necessary, minor grading adjustments shall be made to save these trees. Do no clearing without clear understanding of existing conditions to be preserved.

H. The owner shall be reimbursed should individual trees, shown on the drawings to be protected, become damaged during the course of the work. All expenses incurred shall be paid by the Contractor without additional cost to the Owner.

The owner shall be reimbursed should trees, which are beyond limits of clearing shown on the drawings or beyond limits of clearing approved by the Architect, be cleared or damaged and are part of larger, contiguous wooded areas.

These damaged trees shall be removed from the site, the stumps grubbed and the ground surface repaired. Costs for this removal shall be borne by the Contractor and not be included as part of the above schedule.

I. Fell trees in such a way as not to injure trees to be saved. Trees shall be cut three feet or less from existing grades. All brush or other material shall be cut flush to the ground. All material from clearing operations shall be chipped or cut into log lengths. All piles of chipped material (except those stockpiled for future inclusion in the work) and logs from clearing operations shall be removed from the site prior to or at the end of the clearing work.

J. Limits of clearing shall be those areas shown on the Drawings with modifications as herein specified. Removal of trees, shrubs and bushes outside these areas shall be done only as noted on Drawings.

K. No trees to be saved shall be used for crane stays, guys or other fastenings. Vehicles shall not be parked nor debris burned where damage may result to trees to be saved. Do not permit heavy equipment, materials or stockpiles within branch spread. Remove interfering branches without injury to trunks and cover scars with wound paint.

3.3 INITIAL SEQUENCE OF CONSTRUCTION ACTIVITIES AND PRELIMINARY DRAINAGE CONTROL

A. Prior to beginning grubbing and topsoil stripping operations, the Contractor shall perform the following sequence of construction operations to minimize erosion and siltation on the lower parts of the site.

1. Prior to grubbing or topsoil stripping, place all haybales, silt fence visual barrier, and catch basin filter fabric protection at the edge of the limits of work and in the location shown on the Drawings. Although installation of these measures can be phased according to the construction schedule, haybales, silt fence and visual barrier must be in place prior to any work in a specific lo-

cation. During grubbing and topsoil operations, extend haybales and silt fence as necessary and maintain these until siltation sumps or other erosion control measures can be constructed. Provide all necessary erosion and siltation control measures to eliminate erosion or siltation from occurring beyond the limits of work.

2. Prior to any earthwork operations, install temporary siltation pumps, filtration dams and swales with check dams in the shown on the Drawings or as otherwise approved by the Architect. Place inlet protection in any downstream catch basins that fall either within the limits of work or beyond the limits of work that will receive silts or sediments from construction operations. These measures may be installed in phases according to the Construction Schedule, but must be completed prior to earthwork operations in the adjacent work area.
3. Should the work require it dewatering trenches, well points, or deep sumps will be required for predrainage of soils in areas where substantial work is to occur below the ground water level. These areas shall be excavated in-the-dry. Construct dewatering trenches, well points, or deep sumps in these areas. Begin immediate pumping of any water buildup in these dewatering trenches or sumps into siltation sumps or other erosion control devices approved by the Architect. During construction and during use of siltation sumps for dewatering, a 12-inch gravel filter shall be placed on the upstream side of the filtration dam. Care shall be taken to pump this water into the siltation sump in such a manner so that water laden with silt and debris will be properly filtered out through the filtration dam and so the gravel filter does not erode from pump water discharge. The gravel filter shall be replaced as necessary when it becomes clogged with silt and debris or does not permit free drainage of water through it to properly maintain its function of filtering out silt and debris. During dewatering, care shall be taken to prevent water from flowing back into the areas being pumped or into adjacent areas. It may be necessary to build a temporary dike around the edges of the siltation sump to prevent water from flowing back into adjacent areas.
4. Begin grubbing and topsoil stripping operations simultaneously with the excavation of the dewatering trenches or deep sumps. It is called to the attention of the Contractor that there are numerous locations within the limits of the work where flowing water will occur during periods of heavy rainfall and from normal rainfall that can be expected during the months that construction will occur. Temporary erosion and siltation control measures will have to be taken during construction to eliminate any erosion and siltation beyond the limits of the work until the permanent measures shown on the Drawings can be installed. All necessary measures shall be taken so this does not occur.
5. Do no grubbing, topsoil stripping or excavation operations in areas where substantial work is to occur below the water table until surface and subsurface water in this area will have drained and soils have reached a stable condition. Prior to beginning the above operations, arrange a meeting with the Architect or his designated representative to observe conditions in this area and discuss methods for proceeding the excavation operations.
6. Damaged or loose haybales and siltation fence shall be replaced as necessary to maintain their function of controlling erosion and siltation. Damaged or broken downs check dams and filtration dams shall be replaced immediately. Catch basin filter fabric protection shall be replaced as necessary to maintain its function of controlling erosion and siltation.

7. Remove any accumulation of silt or soil buildup behind haybales, check dams and filtration dams, as it occurs. Remove accumulations of silt and soil buildup from the siltation sumps, and silt traps. Replace the gravel filter on the inside of the filtration dams when it becomes clogged with silt or does not permit free drainage of storm water through it, whichever occurs first. During freezing weather, ½" crushed stone may be used in lieu of gravel if approved by the Architect. Remove silt sacks under catch basin grates when they become clogged and replace with new ones.
8. Throughout excavation, filling and grading operations, in addition to drainage swales, check dams, siltation sumps, filtration dams and other items shown on the Drawings, the Contractor shall take other necessary precautions, including installation of temporary drainage swales, siltation sumps, filtration dams, check dams, haybales, siltation fence and temporary pipe to direct and control drainage from disturbed areas on the site so that erosion and siltation is minimal. In addition, no erosion or discharge of silt or larger particles shall occur onto adjacent properties.

B. If the Contractor anticipates deviations from the above procedures, he shall notify the Architect or his designated representatives as soon as possible. No substantial deviations from the above sequence of activities shall take place without the Architect's or his designated representative's approval.

C. The Contractor shall maintain these erosion control measures for the duration of this Contract or until they no longer function for their intended purpose, as determined by the Architect.

D. All silt and collected debris shall be removed from the sumps prior to backfilling of these areas.

3.3 GRUBBING

A. Limits of grubbing shall coincide with limits of clearing.

B. Remove completely all stones or surface boulders within the topsoil zone, and stumps, roots, matted roots and brush. Exposed boulders or other materials may be removed contiguous with stumps and matted roots. However, this shall be done in such a manner as not to remove topsoil in the same operation such as using a toothed blade to "rake" stones and stumps from topsoil.

C. Stumps and boulders shall be removed form the site and legally disposed of.

3.4 STRIPPING AND STOCKPILING TOPSOIL AND SUBSOIL

A. Prior to the start of General Excavation, strip all topsoil and subsoil from within areas to be regraded, as shown on the Drawings and stockpile where indicated on the Drawings or remove from the site and stockpile off-site if there is not adequate space in the location indicated on the Drawings. Do no stripping without clear understanding of the existing soil, planting and site conditions to be preserved and limits of existing topsoil stockpile and stripped areas.

B. All topsoil encountered during the stripping operations, regardless of depth, shall be removed and stockpiled on the site as shown on the Drawings or where directed by the Architect or removed from the site if the Contractor determines there is adequate topsoil to complete the work and after approval by the Architect. Areas having greater depths of topsoil than indicated on boring data sheets or reasonably anticipated shall be stripped of all such material and fill shall be used to bring such areas to the rough grade level. Stones over six inches and tree roots over two inches in any dimension shall be removed from loam before stockpiling. All other stripped soil that can be classified as fill as defined in Section 310000, EARTHWORK, shall be stockpiled for reuse in rough grading. This material shall be stripped separately from the topsoil. Topsoil and organic materials due to be stripped are as follows:

1. Building Structures, Roads, Parking Areas, Turf and other site improvements except lawn areas – remove completely.
2. Future Lawn Areas –Topsoil shall be removed from adjacent proposed buildings, structures, site improvements, roads and parking areas a distance equal to the depth of fill plus three feet in the particular location, i.e. for a five foot fill, topsoil shall be removed a minimum of eight feet away from the adjacent site improvements.

C. The Contractor shall so control his topsoil stripping operation so that it does not become contaminated with subsoil or other earth materials; the Contractor shall use machinery suitable for achieving this result.

D. Subsoil: The material directly below the topsoil indicated on the test pit logs as “subsoil” shall not be considered usable as Ordinary Fill as specified in Section 310000, EARTHWORK, or for topsoil. The only area where subsoil may be used is under lawn areas. This material shall be stripped separately from the topsoil and from the underlying earth materials. Subsoil shall be stripped as follows:

1. Building Structures, Roads, Parking Areas, Turf and other site improvements except lawn areas – remove completely.
2. Future Lawn Areas, Sub-soil shall be removed from adjacent proposed buildings, structures, site improvements, roads and parking areas a distance equal to the depth of fill plus three feet in the particular location, i.e. for a five foot fill, topsoil shall be removed a minimum of eight feet away from the adjacent site improvements.

E. All excess subsoil encountered in earthwork operations shall be removed from the site and legally disposed of. Topsoil shall be stockpiled as described hereinabove.

F. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.

G. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. The Contractor is responsible for all construction, protection, movement and maintenance of stockpiles. Stockpiles shall be neatly trimmed and graded to provide proper drainage from their surfaces and maintained so as not to erode or pollute their surroundings.

H. The Contractor shall take reasonable care to avoid creating unsightly or unsafe conditions and to avoid unnecessary damage or injury to surroundings.

I. Do not stockpile topsoil within tree protection zones.

J. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

K. Topsoil which has been stripped and stockpiled, but is not needed after the completion of all final topsoil and grassing shall be disposed of offsite. Prior to the disposal of any stockpiled excess topsoil offsite, the Contractor shall offer any excess topsoil to the Architect for their use.

3.5 RESTORATION OF SITE ITEMS

A. Wherever streets, lawns or other items within or outside the Contract Limit Lines have been damaged in fulfilling the work required under this Contract, the Contractor shall furnish and install all material at no cost to the Owner to bring finish surfaces level with the existing adjacent conditions. All work shall be installed to match the existing conditions. Notify the proper authorities, if required, prior to restoring surfaces outside the Contract Limit Lien to assure conformance to existing requirements.

3.6 REMOVAL OF EROSION CONTROL

A. At the time of acceptance of lawns by the Owner, Contractor shall remove all remaining erosion control devices such as silt fence, haybales, and visual barrier and legally dispose of them offsite.

3.7 DISPOSAL OF WASTE MATERIALS

A. Removal from the Subject Property: Remove waste materials and unsuitable and excess topsoil and dispose of offsite in a legal manner. Waste materials shall include but not be limited to timber, brush, refuse, stumps, roots, vines, debris and other objectionable matter. All timber designated in the field by the Architect to not be disposed of by the Contractor shall be stored at a nearby location for ultimate disposal by the Architect.

B. Burning of cleared and grubbed materials, or other fires for any reason will not be permitted.

C. No rubbish or debris of any kind shall be buried on the site.

3.8 IDENTIFICATION OF TREES AND SHRUBS TO REMAIN

A. Prior to starting site clearing operations, stake out all areas of trees and shrubs to be saved as noted on the Contract Documents for approval by the Architect.

B. The Contractor shall be responsible for the protection of all existing trees and plants designated to remain for the length of the construction period, including liability for all damages as specified herein. The placement of protection devices additional to those specified shall, however, bet at the Contractor's discretion and with no additional cost to the Architect.

3.9 REFERENCE POINTS

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. The Contractor shall conduct a benchmark survey throughout the Site to verify the accuracy of the benchmarks shown on the Drawings.

C. The Contractor shall install benchmarks prior to commencing work in areas, which will not be disturbed so at any time there is a benchmark within 250 feet of all portions of the work.

3.10 PROTECTION OF EXISTING UTILITIES

A. Protect existing site improvements from damage during construction.

B. Restore damaged improvements to their original condition, as acceptable to the Architect.

C. All areas disturbed through the removal and disposal of existing utilities and site improvements outside the limits of final grading shall be loamed and seeded or paved to match or exceed existing conditions.

D. The Contractor shall protect existing utility poles, overhead wires, and other electrical or communications elements within and adjacent to the property.

E. Any damage to these utilities or structures resulting from the construction operation shall be repaired to meet or exceed the existing condition at the Contractor's expense.

F. Any losses to the property or any other utility company resulting from the interruption of service from construction or blasting activity, both directly or indirectly, shall be the responsibility of the Contractor, and shall result in no additional cost to the Architect.

G. The Contractor shall make every effort to protect existing utilities including electrical and communications conduits and structures during construction. Any damage to utilities designated to remain shall be repaired immediately at the Contractor's expense.

End of Section

Section 31 23 19

DEWATERING AND DRAINAGE

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. A dewatering plan shall be prepared by a licensed Massachusetts Professional Geotechnical Engineer and submitted for review. Submittal of plan does not constitute approval.

B. The objective of this Section is to remove standing water from excavations as needed to perform the work as specified, and collect water which may enter the excavation during Contractor's excavation activity.

C. Contractor will obtain a NPDES Permit and shall be responsible for collecting and analyzing the requisite water samples to meet the Permit requirements. Contractor is responsible for providing this information to the proper regulatory authorities in a manner consistent with the requirements of the Permit.

D. Contractor shall repair damage caused by dewatering and drainage system operations, at no additional cost to the Owner.

E. Obtain and pay for all permits required for temporary dewatering and drainage system.

F. Furnish, install, operate, monitor, maintain and remove temporary dewatering and drainage systems as necessary to lower and maintain groundwater levels below subgrades of excavations. Prevent surface water runoff from entering or accumulating in excavations.

G. Collect and properly dispose of all water from dewatering and drainage systems in accordance with local, State and Federal requirements and permits.

H. Remove temporary dewatering and drainage systems when no longer needed. Restore all disturbed areas.

1.4 RELATED WORK

A. Earth excavation and backfill are included in Section 31 00 00 – EARTHWORK.

B. Demolition procedures are included in Section 02 41 00 – SITE DEMOLITION.

C. Submittals are included in Section 01 33 00 – SUBMITTAL PROCEDURES.

1.5 SUBMITTALS

A. Shop Drawings for Information in accordance with Section 01 33 00 as part of the Work Plan: For dewatering system. Show arrangement, locations, and details of

wells and well points; locations of headers and discharge lines; and means of discharge and disposal of water.

1. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
2. Include a written report outlining control procedures to be adopted if problems arise with the proposed system.
3. Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation with geotechnical expertise, retained by the Contractor.
4. Submittal will be for information only. The Contractor shall remain responsible for adequacy, safety, and compliance with appropriate local, state and federal regulations, of construction means, methods and techniques.

1.6 DEFINITIONS

A. Where the phrase “in-the-dry” is used in these specifications, it shall be defined as the in-situ soil moisture content, which will allow the excavated soils to be managed without the generation of free liquids.

1.7 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by the User Agency or others unless permitted in writing by the Architect and then only after arranging to provide temporary utility services according to requirements indicated.

B. Groundwater is anticipated to be encountered throughout construction. Groundwater has been monitored on the following date

PART 2 – PRODUCTS (NOT SPECIFIED)

PART 3 - EXECUTION

3.1 GENERAL

A. Contractor shall control surface water and groundwater such that excavation to final grade is made in-the-dry, and bearing soils are maintained undisturbed, Contractor shall prevent softening, or instability of, or disturbance to, the subgrade due to water seepage.

B. Contractor shall provide protection against flotation for all work.

C. The impact of anticipated subsurface soil/water conditions shall be considered when selecting methods of excavation and temporary dewatering and drainage systems. Type of dewatering system, spacing of dewatering units and other details of this work shall address site specific conditions.

D. Contractor shall take all necessary measures to prevent damage to adjacent structures, utilities, property(ies), and other features.

E. Contractor shall modify, redesign, and/or replace the dewatering system at no additional cost to the Owner, if design criteria are not continuously and effectively fulfilled.

F. Contractor shall repair damage to adjacent structures, utilities, and properties resulting from the operation of the Contractor's dewatering and treatment system, at no additional cost to the Owner.

G. Contractor shall locate dewatering facilities where they will not interfere with utilities, the safe passage of traveled ways, or other work to be done on the Site under the Specifications.

H. Contractor shall take all necessary precautions during dewatering activities to prevent adverse effects on the Site and on adjacent properties.

3.2 SURFACE WATER CONTROL

A. Contractor shall control surface water runoff to prevent flow into excavations, and shall provide temporary measures such as dikes, ditches and sumps.

3.3 EXCAVATION DEWATERING

A. Contractor shall provide and maintain adequate equipment and facilities to remove promptly and dispose of properly all water entering excavations. Contractor shall keep excavations in-the-dry, so as to maintain an undisturbed sub grade condition throughout construction below grade, including backfill and fill placement.

B. Contractor shall collect precipitation or surface runoff in shallow ditches around the perimeter of the excavation, drain to sump and pump from the excavation to maintain in-the-dry conditions.

C. Dewatering and drainage operations shall at all times be conducted in such a manner as to preserve the natural undisturbed bearing capacity of the sub grade at the bottom of the excavation. If the sub grade becomes disturbed for any reason, the unsuitable sub grade material shall be removed and replaced with concrete, compacted granular fill, or other approved material to restore the bearing capacity of the subgrade to its original undisturbed condition.

D. Dewatering and drainage operations shall be conducted in a manner that does not cause loss of ground or disturbance to the pipe bedding or soil that supports overlying or adjacent structures.

3.4 DISPOSAL OF DRAINAGE

A. All water collected in temporary drainage systems will be collected in the dewatering system and disposed of in the same manner as the dewatered groundwater.

B. The Contractor shall be responsible to ensure that such discharge does not lead to groundwater mounding or other conditions that are not in compliance with the Massachusetts Contingency Plan (310 CMR 40.0000) or the Massachusetts Groundwater Discharge Permit Program 314 CMR 5.00. If discharge is conducted in accordance with a Pretreatment Permit, Contractor is responsible for completing applicable laboratory analysis and maintaining compliance with all permit conditions. Contractor is also responsible for all consequences of non-compliance and/or permit violations. If discharge is completed through off-site disposal, the Contractor is responsible for completing all necessary laboratory analysis to ensure material is within the permit requirements of the accepting facility.

3.5 DISPOSAL OF INCIDENTAL SEDIMENT

A. Other then the collected solids from filtration, any sediment, solids, sludge or soil which accumulates as a result of the dewatering operation, either within the dewatering equipment or external to it, shall be removed from the equipment and the Site and disposed of at no additional cost to the Owner.

End of Section

Section 31 25 00

EROSION CONTROL

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 1 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. This Section specifies requirements for control of erosion from the Limits Work onto adjacent down gradient areas as shown on the Drawings, as specified herein for applicable construction activities.

B. Furnish and install hay bales, silt fence, swales, soil berms, mulches, grasses, channels, crushed stone, rip-rap, grading to control runoff, dewatering filter basins, and all other devices required to control erosion. Continually maintain all erosion control devices within the limits of the contract areas. Remove and clean up of all erosion control devices within the limits of the contract areas.

C. RELATED WORK: The following items are not included in this Section and will be performed under the designated Sections.

1. Section 31 00 00, Earthwork for excavation, backfilling and compaction requirements
2. Section 33 40 00, Storm Drainage for installation of Storm Drainage System

1.3 APPLICABLE REGULATIONS

A. In order to prevent erosion and sedimentation from construction activities related to the performance of this project, the Contractor and his subcontractors shall comply with permits issued for the project, all applicable federal, state and local laws and regulations concerning erosion and sediment control, as well as the specific requirements stated in this Section and elsewhere in the Specifications.

1. Commonwealth of Massachusetts, Department of Public Works, Standard Specifications for Highways and Bridges, latest edition, herein referred to as the “Standard Specifications” and related articles.
2. Massachusetts “Erosion and Sedimentation Control Guidelines for Urban and Suburban Areas, A Guide for Planners, Designers, and Municipal Officials” prepared by Department of Environmental Protection (DEP), Reprinted May 2003.

1.4 QUALITY ASSURANCE

A. The Contractor shall install and maintain sedimentation control devices during construction as specified and as indicated by the SWPPP to prevent the movement of sediment from the construction site to off site areas via surface runoff or underground drainage systems. Measures in addition to those indicated to prevent the movement of sediment off site shall be installed, maintained, removed, and cleaned up at no additional cost to the Owner.

1.5 DESIGN CRITERIA

A. Conduct all construction in a manner and sequence that causes the least practical disturbance of the physical environment.

B. Stabilize disturbed earth surfaces in the shortest practical time and employ any and all such temporary erosion control devices as may be necessary until such time as adequate that soil stabilization has been achieved or permanent erosion control devices are operational.

C. The erosion control devices specified herein represent the minimum required work for erosion control. The Contractor shall add to these minimum devices any and all measures to effectively prevent migration of sediment from the limits of the work area.

D. Within this Section, the Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas dated 1997 and the Massachusetts Department of Environmental Protection guidelines shall be the standard source for all erosion and sedimentation control procedures.

1.6 SUBMITTALS

A. Refer to Section 01 33 00 – SUBMITTALS for submittal provisions and procedures.

B. At least 5 days prior to the start of any other construction, the Contractor will review the installed erosion controls with the Architect.

C. At least 5 days prior to intended use, the Contractor shall provide the following samples and/or submittals for approval. Do not order materials until the Architect's approval of samples, certifications or test results has been obtained. Delivered materials shall closely match the approved samples.

1. Silt Fence: Submit manufacturer's material specification and installation instructions.
2. Inlet Protection.
3. Mulch Material: Submit one Cubic Foot Sample.
4. Mesh of Matting: Submit One square foot sample and manufacturer's technical description and installation instructions.

D. Implementation Plan

Prior to commencement of the work, the Contractor shall:

1. Meet with the Architect to develop mutual understandings relative to compliance with the provisions of this Section.
2. Install all erosion control measures as specified on the Drawings.
3. Should the Contractor desire to change or modify the specified erosion controls then he shall submit in writing his plans to the Architect for implementing erosion and sediment control including, but not limited to, placement of hay bales, silt fence, containment berms, temporary channels, settling ponds, and dewatering filter basins, as well as a description of all construction techniques intended to minimize erosion and sedimentation, and a program for maintenance of these facilities throughout the performance of construction activities.
4. The Contractor shall submit design and sizes of all dewatering filter basins.

PART 2 – MATERIALS

2.1 HAY BALES

A. Bales shall be made of straw or hay with forty pounds minimum weight and one hundred and twenty pounds maximum weight. They should be either wire or nylon bound. Wood stakes shall be a minimum of 2 inch by 2-inch nominal size by a minimum of 3 feet long. As an alternate, No. 4 size steel reinforcing bars may be used with rubber safety tops.

2.2 SILT FENCE

A. Silt fences or sedimentation barriers shall consist of wood posts with industrial support netting and sediment control filter fabric attached.

B. Wood post shall be standard 2”x2”x4.5’ long hardwood stakes commonly used to support filter fabric. Silt fence shall be furnished standard with filter fabric attached to hardwood posts and spaced at a maximum distance of 8 feet.

C. Provide suitable heavy nylon cord for securing abutting silt fence posts.

D. The filter fabric material shall be needle punched non-woven polypropylene geotextile conforming to the following criteria:

Minimum Acceptance

Fabric Properties	Value	Test Method
Grab Tensile Strength (lbs)	124	ASTM D4632
Elongation of Failure (%)	15	ASTM D4632
Mullen Burst Strength (PSI)	300	ASTM D3786
Puncture Strength (lbs)	100	ASTM D4833
Flow Rate (gal/min/sf)	10	ASTM D4491
Apparent Opening Size (sieve)	30	ASTM D4751
Ultraviolet Radiation (% strength retained)	70	ASTM D4355
Trapezoidal Tear Strength (lbs)	60	ASTM D4533
Permittivity (sec^{-1})	.01	ASTM D4491

E. Control fabric shall be at least 3 feet wide.

2.3 CATCH BASIN INSERTS

A. Siltsack®, Basin bag, Ultra-BasinGuard or equal shall be manufactured from a specially designed woven polypropylene geotextile. The insert will be manufactured to fit the opening of the catch basin or drop inlet.

2.4 FILTER SOCKS

A. Filter Socks are biodegradable sediment-trapping devices. Manufacturers include SiltSoxx, Corr Logs, Straw Wattles, or equivalent.

2.5 STONE STABILIZATION PAD

A. Material as shown on Drawings to ensure no offsite tracking of soil.

2.6 WATER

A. Water used for dust control and equipment washes shall be clean and free of salt, oil, and other injurious materials. Water is not available on site. The Contractor shall provide all necessary water.

PART 3 – EXECUTION

3.1 GENERAL EROSION CONTROL REQUIREMENTS

A. All materials and installation shall be in accordance with the Drawings.

B. Means of protection as noted on the Drawings indicate the minimum provisions necessary. Additional means of protection shall be provided by the Contractor as needed for continued or unforeseen erosion problems, at no additional expense to the Owner.

C. The Architect has the authority to control the surface area exposed by construction operations and to direct the Contractor to immediately provide permanent or temporary erosion control measures to prevent contamination of adjacent streams, watercourses, lakes, ponds or other areas of water impoundment. Every effort shall be made by the Contractor to prevent erosion on the site and abutting property.

D. All slopes shall be stabilized by mulching, seeding or otherwise protected as the work progresses to comply with the intent of this specification. All damaged slopes shall be repaired as soon as possible. The Architect shall limit the surface area of earth material exposed if the Contractor fails to sufficiently protect the slopes to prevent pollution.

E. The Contractor shall at all times have on hand the necessary materials and equipment to provide for early slope stabilization and corrective measures to damaged slopes.

F. The Contractor shall continually maintain all erosion control devices within the contract work limit and shall remove such devices upon completion of the Work and surface stabilization, or if ordered by the Architect.

G. The Contractor shall operate all equipment and perform all construction operations

so as to minimize pollution. The Contractor shall cease any of his operations, which will increase pollution during rainstorms.

H. The Contractor shall place additional erosion and sedimentation controls in accordance with by laws and regulations.

I. After any significant rainfall (more than 1 inch of rainfall in a 24 hour period), sediment control structure shall be inspected for integrity. Any damaged devices shall be corrected immediately.

3.2 HAY BALE INSTALLATION

A. Bales shall be set lengthwise on the contour for sheet flow applications. They shall be held in place by two wooden stakes in each bale as detailed on the Drawings. Bales shall be maintained or replaced until they are no longer necessary for the purpose intended or are ordered removed by the Architect.

B. Bales shall be set with bindings parallel to grade and entrenched to a minimum depth of 6 inches. Stakes shall be driven a minimum of 18 inches into the ground and cut off flush with the top of the bale.

C. After the bale lines are staked, the end joints shall be chinked with loose straw to close any gaps. Excavated soil shall then be backfilled against the uphill side of the barrier to a depth of 4 inches above the downhill grade.

D. Inspection shall be weekly and repair or replacement shall be made as needed.

E. Following compaction of the backfill, loose straw shall be scattered over the surface directly behind the barrier.

F. Hay bale checks should be placed in diversions generally at 50-foot intervals and in accordance with the detail on the Drawings. Sediment shall be removed from behind the checks when it has accumulated to one-half the original height of the dam measured at the low point.

3.3 SILT FENCE INSTALLATION

A. Silt fence shall be installed utilizing posts 4.5 feet long minimum staked at least 8' on center. Prior to installation, a 6-inch by 8-inch deep anchor trench shall be installed at the base of the fence and the final height will be at minimum 2 feet.

B. Inspect siltation fence periodically and remove accumulated sediment.

3.4 DIVERSIONS

A. Diversions for directing surface runoff away from and/or around trenching and other construction operations shall be installed and stabilized in advance of new work. The Contractor shall select the cross-Sectional shape (parabolic, v-shaped or trapezoidal) of diversions and shall have proper equipment available on-site for maintenance of the diversions.

B. The minimum capacity of the diversion shall be sized to accommodate a 2-year design storm.

C. Periodic cleaning shall be done to maintain capacity.

3.5 DEWATERING DISCHARGES

A. All pumped discharges and surface water flow from work areas shall be passed through a filter barrier of hay bales and silt fence combination or dewatering bags before being discharged into gutters, ditches, drainage swales, storm sewer systems, wetlands, natural water bodies, streams, or rivers. The method of all such discharges shall be subject to the approval of the Architect.

B. The Contractor shall design and size all dewatering discharge basins such that the discharge from the basins is free of silt and debris to the satisfaction of the Architect and all applicable regulatory agencies.

3.6 CATCH BASIN INSERTS

A. Installation of inserts shall be prior to any upstream soil disturbance.

B. Inserts shall be inspected after each rain event and at a minimum every two weeks.

C. Debris and silt shall be cleaned on a regular basis.

3.7 REMOVAL AND CLEAN-UP

A. All temporary erosion control facilities and accumulated sediments shall be removed and legally disposed in a neat and workmanlike manner when all disturbed areas have been satisfactorily stabilized.

End of Section

Section 32 00 00

BITUMINOUS CONCRETE PAVEMENT, CURBING AND EDGING

PART 1 – GENERAL

1.1 Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 1 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

1.2 WORK TO BE PERFORMED

A. Work under this section includes installation of bituminous concrete pavements, curbing and pavement markings for roadways and parking areas as shown on the Drawings. All existing pavement to remain, but damaged, as a result of the construction operations, shall be restored in accordance with the requirements of this Section. Trench fills for trench excavations through roadways shall consist of general pavement structures according to this Section.

B. The Contractor shall install all pavement and drives, which have been removed or damaged during construction operations. Pavement shall include satisfactory repair by the Contractor of driveways and any other surface disturbed by his/her operations by the same materials as removed or as specified herein. Driveway aprons shall be part of the work.

C. Items to be Installed:

1. Concrete Curbing
2. Granite Curbing
3. Pavement Markings
4. Bituminous concrete curbs
5. Paving

D. Related Work:

1. Section 31 00 00 – EARTHWORK
2. Section 31 23 19 – DEWATERING AND DRAINAGE
3. Section 32 17 23 – PAVEMENT MARKINGS
4. Section 03 30 00 – CAST-IN-PLACE CONCRETE

1.3 REFERENCES

A. All work specified in this Section shall conform to the Commonwealth of Massachusetts Standard Specifications for Highway and Bridges latest revision, herein referred to as "State Standards".

B. All work specified in this Section shall conform to the Rules and Regulations governing the Subdivision of Land in the Town of Plymouth, Massachusetts.

C. American Society of Testing and Materials (ASTM) (latest edition):

1. C 33 Specification for Concrete Aggregates.

2. C 136 Method for Sieve Analysis for Fine and Coarse Aggregate.
3. C 140 Sampling and Testing Concrete Masonry Units.
4. C 144 Standard Specifications for Aggregate for Masonry Mortar.
5. C 936 Specifications for Solid Interlocking Concrete Paving Units.
6. C 979 Specification for Pigments for Integrally Colored Concrete.
7. D 698 Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 5.5 lb (24.4 N) Rammer and 12 in. (305 mm) drop.
8. D 1557 Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 10-lb (44.5 N) Rammer and 18 in. (457 mm) drop.
9. D 2940 Graded Aggregate Material for Bases and Subbases for Highways or Airports.
10. C 29 Bulk Density and Voids in Aggregate Materials.

1.4 PRODUCT HANDLING

A. Use all means necessary to protect bituminous concrete pavement materials before, ongoing, and after installation, and to protect the installed work and materials of all other trades.

B. In the event of damage, immediately make all repairs and replacements necessary as directed by the Architect.

1.5 SUBMITTALS

A. The Contractor shall submit to the Architect, data showing gradation and composition of materials proposed.

B. The bituminous concrete mix formula must be submitted to the Architect prior to the initiation of paving operations.

1.6 QUALITY CONTROL

A. For actual finishing of bituminous concrete surfaces and operation of the required equipment, use only personnel who are thoroughly trained and experienced in the skills required and whose prime occupation is this type of work.

B. Existing paved areas damaged or removed shall be repaired or replaced, respectively, with the same materials and level of quality as on the Project.

1.7 GUARANTEE/WARRANTY

A. Material Guaranty: Before any contract is awarded, the Bidder may be required to furnish without expense to the Architect complete statement of the origin, composition and manufacture of any or all materials proposed to be used in the construction of the work, together with samples, which may be subjected to the tests required by the Architect to determine the quality and fitness of the material.

PART 2 – MATERIALS

2.1 MATERIALS

A. Subgrade base course material shall conform to the applicable subsections of Section 310000, Earthwork of this Specification.

B. Bituminous Concrete Pavement shall conform to the applicable subsections of Section 460, Class I Bituminous Concrete Pavement, Type 1 of the “Standard Specifications.”

2.2 PAVEMENT BASE

A. Conform to Sand Gravel Fill as specified in Section 31 00 00, EARTHWORK.

2.3 PAVEMENT SUB BASE

A. Conform to granular fill as specified in Section 31 00 00, EARTHWORK.

2.4 SUBGRADE

A. Reuse on-site material or imported material as specified in Section 31 00 00, EARTHWORK.

2.5 CONCRETE CURBING

A. All curbing shall placed so that areas behind curbs shall be graded smooth, and topsoil and seed shall be placed.

B. Concrete curbs shall be in accordance to MHD Standard Specifications M9.04.1 and installed in accordance to MHD Std. Spec. Section 500.

C. Concrete curb inlets shall conform to M9.04.5 and the Town of Plymouth standards.

2.6 GRANITE CURBING

A. All curbing shall be placed so that areas behind curbs shall be graded smooth, and topsoil and seed shall be placed.

B. Granite curbs shall be in accordance to MHD Standard Specifications M9.04.1 and installed in accordance to MHD Std. Spec. Section 500.

C. Granite curb inlets shall conform to M9.04.5 and the Town of Plymouth standards.

2.7 BITUMINOUS BERM / CURB

A. Bituminous berm shall be Class I Bituminous Concrete, Type I-1 in accordance with MHD Standard Specifications Section 470.

PART 3 – EXECUTION

3.1 GENERAL REQUIREMENTS

A. Contractor Requirements:

1. The Contractor shall perform and complete the Work within the limits indicated in a continuous manner so that the pavement placement work may proceed without delay.
2. The Contractor shall, at all times, prior to acceptance of the work by the

Architect, maintain the completed work in a safe and satisfactory condition. All maintenance and repairs to the completed work shall be subject to the approval of the Architect and the controlling municipal and State authorities. All maintenance and repairs of the completed work shall be provided by the Contractor at no additional cost to the Architect.

3. Equipment used in the work will be subject to approval by the Architect and shall be maintained in a satisfactory condition at all times. Unless otherwise permitted, compaction shall be performed by use of suitable power rollers. Finished surfaces of new asphaltic surface courses shall finish even with adjacent existing pavement surfaces and be free from surface irregularities.
4. It shall be the responsibility of the Contractor to obtain from the controlling municipal authorities all required permits for cutting roadway pavements and to perform the work in accordance with all customs and requirements of the controlling authorities, in addition to those specified herein, and at no additional expense to the Architect.
5. Existing pavements outside of the indicated work limits which are damaged as a result of the Contractor's operations, including base courses, bituminous tack coats and surface courses, shall be replaced by the Contractor in accordance with the requirements specified herein for the respective type of pavement; in a satisfactory manner and at no additional cost to the Architect.
6. In case of settlement or other defects in new or replaced pavements, the Contractor shall cut out, replace, restore or repair the damaged pavements at no additional expense to the Architect. This requirement shall remain in effect for 2 years after the acceptance of the work by the Architect. The pavement area to be replaced, repaired or restored, shall extend from edge of pavement to edge of pavement, a minimum of 20 feet on either side of the defect; final pavement course shall be feathered to provide a smooth finish detail.
7. This Contract shall not be considered complete until the replacement, restoration and repair of pavements has been provided in a manner satisfactory to the Architect, and in accordance with the requirements specified herein.

B. All materials and each part of detail of the work shall be subject to inspection by The Architect. The Architect shall be allowed access to all parts of the Work and shall be furnished with such information and assistance by the contractor as is required to make a complete and detailed inspection, (such assistance may include furnishing labor, tools, and equipment, at no expense to the Architect.)

C. If the Architect so requests, the Contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the Work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed will be paid for as extra work; but should the work so exposed or examined prove unacceptable, the uncovering or the removing and the replacing of the covering or making good of the parts removed, will be at the Contractor’s expense.

D. Any work done or materials used without authorization by the Architect may be ordered removed and replaced at the Contractor’s expense. The Contractor shall furnish written information to the Architect stating the original sources of supply of all

materials manufactured away from the actual site of the work. In order to insure a proper time sequence for required inspection and approval this information shall be furnished at least two weeks in advance of the incorporation in the work of any such materials.

E. For the purpose of observing work that affects their respective properties, inspectors for the municipalities, public agencies and the utility companies shall be permitted access to the work, but all official orders and directives to the Contractor will be issued by the Architect.

F. The inspection of the work shall not relieve the Contractor of any of his obligations to fulfill the terms of the Contract a herein prescribed by the plans and specifications.

G. Failure to reject any defective work or materials shall not in any way prevent later rejection when such defect is discovered, nor obligate the Architect to make final acceptance.

H. The Contractor shall give prior notice to the Architect when work on the various items is to be performed by him or his Subcontractors. If work is suspended on any item, prior notice shall be given to the Architect before resumption of such work.

3.2 SUBGRADE PREPARATION

A. Prepare subgrade by shaping and compacting to proper grade. Remove all soft and yielding material from the subgrade and replace with suitable material. Compact thoroughly using approved types of rollers or tampers. Insure that all areas are stable and dry.

B. Saw cut edges of existing pavement along even lines to obtain undisturbed, clean and sound vertical edges of original pavement.

C. Do not store or stockpile materials on the subgrade.

3.3 PAVEMENT

A. The subbase to be placed under pavement shall consist of at least 12 inches of base course as specified in Section 31 00 00, Earthwork, evenly spread and thoroughly compacted.

1. Compaction of the subbase shall be in accordance with Section 31 00 00 Earthwork
2. All thicknesses are measured after rolling. The permanent surface course shall be evenly spread and rolled with a power roller having a minimum weight of 5 tons.

3.4 COMPACTION

A. The Contractor shall conform to the State Standards for pavement operations, including compaction (401.03.10).

B. Immediately after the bituminous mixture has been spread, struck off, and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling. The surface shall be rolled when the mixture is in the proper condition and when rolling does not cause undue displacement, cracking and shoving.

C. The number, weight and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. Rolling shall be continued until all roller marks are eliminated and the minimum densities have been obtained based upon 95 percent of laboratory Marshall Densities made in the proportions of the job-mix formula, AASHTO T-245.

D. Steel-Tired, Static Weight Rollers: The maximum roller speeds for steel-tired static-weight rollers for various operations shall not exceed three miles per hour. The wheels of steel-wheel rollers shall be kept moist and clean to prevent adhesion of the fresh material, but an excess of water will not be permitted.

E. Vibratory Rollers: The maximum roller speed for vibratory rollers shall be that which provides impact spacing less than the compacted lift thickness. When vibratory rollers are used in the static mode, roller speed shall not exceed three miles per hour.

1. When an approved vibratory roller is used for breakdown rolling in a vibratory mode, intermediate rolling will not be required. When the vibratory roller is used for finish rolling it shall be used in the static mode. Rolling shall progress continuously until the specified density of the corresponding daily plant Marshall Density, AASHTO T-245 has been attained. Finish rolling shall continue until all roller marks are eliminated.

F. Unless otherwise directed, rolling shall start longitudinally at the sides and gradually progress toward the center of the pavement.

G. The motion of the rollers shall be slow enough at all times to avoid displacement of the hot mixture. Any displacement resulting from reversing the direction of the rollers or from any other cause shall be satisfactorily corrected.

H. When the base course or binder course fails to comply with the density requirements herein specified, additional compaction may be applied when permitted and as directed, to attain the required density. If satisfactory density cannot be attained the Contractor shall be required to remove and replace, at his own expense, any affected area, which is proven to be structurally inadequate and/or incapable of maintaining material integrity.

I. Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective, shall be removed and replaced with fresh hot mixture, which shall be compacted to conform to the surrounding area. Any area showing an excess or deficiency of bituminous material shall be removed and replaced.

J. In the event of dispute as to the creditability of the results, density shall be determined from cores taken from the pavement.

3.5 FIELD QUALITY CONTROL

A. Thickness: Test in-place asphalt concrete courses for compliance with requirements for thickness. Repair or remove and replace unacceptable paving as directed by the Architect. In-place compacted thickness will not be acceptable if exceeding following allowable variation from required thickness.

B. Compaction:

1. The Bituminous mixture shall be compacted to at least 95% of the density

achieved on the laboratory testing of the design mix for the project.

2. Density will be checked by the Nuclear Density gage Method, ASTM 2950.

C. Guarantee: During the two-year guarantee period, the Contractor shall maintain the surfacing and shall promptly fill with similar material in compliance with the above specifications, any depressions and hold that may occur so as to keep the surfacing in a safe and satisfactory condition for traffic.

End of Section

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Section 32 12 17
TENNIS COURT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

B. Related Sections:
1. Section 11 68 00 - Play Field Equipment and Structures
2. Section 31 00 00 – Earthwork
3. Section 32 00 00 – Bituminous Concrete Pavement
4. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
5. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
6. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

1.2 DESCRIPTION OF WORK

A. This work shall consist of all work necessary and required for the construction of tennis courts. Such work includes, but is not limited to, the following:
1. Gravel base
2. Bituminous concrete courses
3. Colored filler coats
4. Acrylic line paint

1.3 PROTECTION

A. Entire tennis court area shall be protected from damage until accepted. All damaged items shall be removed and replaced. Refinishing of pavement and color coating may be required after being reviewed with Owner's Representative. In any case, all work shall be done at no expense to the Owner.

1.4 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division I.
1. Submit product data for all pre-manufactured material.

B. Submit samples showing finish and color of materials for approval of the Owner.

C. Provide drawings of manufacturers installation requirements.

D. All submittals must be prior to fabrication and or field installation work.

E. Manufacturer's Certification: Submit manufacturer's certification that materials comply with specified requirements and are suitable for intended application.

F. Manufacturer's Project References: Submit manufacturer's list of successfully completed asphalt tennis court surface color coating system projects, including project name, location, and date of application.

G. Applicator's Project References: Submit applicator's list of successfully completed asphalt tennis court surface color coating system projects, including project name, location, type and quantity of color coating system applied, and date of application.

H. Warranty certificates included by these specifications (including both **Manufacturers** and **Installers** warrantees).

I. Prior to final acceptance, the Contractor shall submit to the Owner three (3) copies of maintenance manuals, which will include all necessary instructions for the proper care and preventative maintenance of a synthetic track surface.

J. Sustainable Design Submittals:

1. Recycled content: Provide manufacturer's written certification of recycled content as defined in accordance with International Standard ISO 14021–1999, Environmental Labels and Declarations—Self-Declared Environmental Claims (Type II Environmental Labeling). Indicate post-consumer and pre-consumer recycled content and provide documentation certifying products are from recycled sources. (LEED Credit MRc4).
2. Local/regional materials (LEED Credit MRc5):
   a. Indicate location of content of extraction, harvesting, and recovery; indicate the distance between extraction, harvesting, and recovery and the project site. Indicate percentage of product content from qualified locations.
   b. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
3. Adhesives and Sealants: Include certification of data indicating Volatile Organic Compound (VOC) content of all field-applied adhesives and sealants and compliance with California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda. Submit MSDS highlighting VOC limits. (LEED Credit IEQc4.1).

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
1. Manufacturer regularly engaged, for past 5 years, in manufacture of asphalt tennis court surface color coating systems of similar type specified.
2. Member: American Sports Builder Association.

B. Applicator's Qualifications:
1. Applicator regularly engaged, for past 3 years, in application of tennis court surface color coating systems of similar type to that specified.
2. Employ persons trained for application of tennis court surface color coating systems.

1.6 PROJECT CONDITIONS

A. Do not apply asphalt tennis court surface color coating system when air or surface temperatures are below 50 degrees F during application or within 24 hours after application.

B. Do not apply asphalt tennis court surface color coating system when rain is expected during application or within 24 hours after application.

1.7 WARRANTY

A. Request, receive and forward to the owner two (2) copies of a written warranty from the manufacturer stating that all work executed under this section will be free from defects of material for a period of five (5) years from the date of project completion and that any defects will be remedied upon written notice at no additional cost to the Owner. This warranty shall not cover items damaged by improper use of vandalism as determined by the Owner.
   1. The warranty submitted shall have the following characteristics:
      a. Provide full coverage for five (5) years from the date of substantial completion.
      b. Warrant materials and workmanship.
      c. Warranty shall be provided by both installer and manufacturer and must ensure that the materials installed meet or exceed the product specifications.
      d. Provision to either make a cash refund or repair or replace such portions.
      e. Guarantee the availability of replacement material for the synthetic surface system.

1.8 COORDINATION

A. Coordinate work with other trades so that no damaged is done to this work or any other trade, including but not limited to, fencing, and paving contractors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is NOT a proprietary specification and it should be noted that "or equivalent" applies to all products denoted herein. It is understood that all manufacturers will have minor variations in configuration, appearance, and product specifications and such minor variations shall not eliminate such manufacturers as an equivalent. It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that are able to supply similar products.

B. Gravel Base: Gravel Base material shall conform to applicable portions of Section 31 00 00 "Earthwork".

C. Dense Graded Aggregate: Dense Graded Aggregate shall be ¾" processed stone and shall conform to applicable portions of Section 31 00 00 "Earthwork".

D. Bituminous Concrete Base Course: Bituminous Concrete Base Course shall conform to applicable portions of Section 32 00 00 "Bituminous Concrete Paving".

E. Bituminous Concrete Wearing Course: Bituminous Concrete shall conform to Section 32 00 00 "Bituminous Concrete Paving" with the exception that the aggregate gradations shall not exceed 3/8 inch in maximum size in any case.

F. Leveling Course: Two coats of "Novafil" or approved equivalent shall be applied to entire tennis court area, or equivalent.

G. Finish Coat: One coat of "Novacoat" or approved equivalent shall be applied to entire tennis court area. The color of the playing area shall be "BLUE" ("Color A" on plans) and "LIGHT GREEN" ("Color B" on plans) for the out-of-bounds areas. Colors shall be verified by Owner.

H. Line Paint: Line Paint shall be a 100 percent acrylic emulsion type, non-glaring, highly reflective, fast drying that will not cause crazing, cracking and peeling. Paint shall be "Novatex" line paint for spray application, or approved equivalent.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Construct courts and install tennis items where indicated on plans and detailed therein.

B. Subgrade: The Contractor shall prepare a suitable subgrade at an elevation that shall accommodate the gravel base, bituminous concrete, and color system, meeting the required proposed grades. The subgrade shall be thoroughly dry and compacted to 95% Standard Proctor. Slope shall be established in sub-grade and shall be all in one direction as indicated on the plans.

C. Gravel Base: Provide gravel base conforming to Section 31 00 00 "Earthwork". Provide a minimum depth of eight (8) inches of gravel and a four (4) inch lift of ¾" dense graded aggregate, thoroughly rolled and compacted, and shall conform to the grades and cross sections specified. Maintain pitch with gravel fill.

D. Bituminous Concrete Base Course: A bituminous concrete base over the gravel base course shall be applied at a 1 ½" thickness conforming to Section 32 00 00 "Bituminous Concrete Paving". This course shall be laid to obtain required slope, pitch and grade with no variations greater than ¼" along a 10' straight edge in any direction.

E. Bituminous Concrete Wearing Course: A final bituminous concrete surface course shall be applied at a 1 ½" thickness conforming to this section and Section 32 00 00 "Bituminous Concrete Paving". Application shall be made to attain final required slope, pitch, and grade with no variations greater than 1/8" along a 10' straight edge in any direction. The surface shall be rolled free of any roller marks, ridges, and voids. The surface shall be checked by flooding and marked for depressions. Any depressions greater than 1/8" shall be repaired by a trowel application of "Novafil". The asphalt shall cure for seven (7) days prior to applying the Color System. The surface shall be brushed and/or blown free of all dirt and foreign matter.

F. Nova Color System: Prior to applying the finish coat, a final, careful inspection of the entire surface shall be made to remove any ridges, loose or foreign particles.
   1. Apply two coats of "Novafil" in accordance with the manufacturer's directions, or approved equivalent.
   2. Apply one coat of "Novacoat" colors in the locations shown on the plans and in accordance with the manufacturer's directions.
   3. Apply 2" wide white line markings conforming to U.S. Lawn Tennis Association Specifications. **Base lines shall be 3"**. "Novatex" textured line paint (100 percent acrylic latex) may be applied by brush or spray, free of any fogging or over spray. Rate of application is in accordance with the manufacturer's directions. **Note: It is preferred to tape lines and brush paint.**

3.2 SPECIAL INSTRUCTIONS

A. The final pitch of the finished surface shall be as shown on plans.

B. Upon completion, the Contractor shall remove all containers, surplus materials and debris and leave the site in a clean and orderly condition acceptable to the Owner.

3.3 PROTECTION

A. Allow a minimum of 24 hours curing time before opening tennis courts for play.

B. Protect applied asphalt tennis court surface color coating system to ensure that, except for normal weathering, coating system will be without damage or deterioration at time of Substantial Completion.

C. Materials specified for the color system shall be delivered to the site in sealed, properly labeled containers and water used in all mixtures shall be fresh and clear. Spreading rates are based upon material prior to mixing with water as directed.

D. The Contractor shall be responsible for any damage or discoloration to abutting/adjacent ground, grass or other surfaces in the area.

E. Check grades and levels to make certain that surface is free of puddles or standing water and depressions greater than 1/8” in any direction with a ten-foot straight edge. The entire area of tennis courts shall be “flooded” and after one hour of sun, checked by Contractor prior to color coating. Any puddle deep enough to cover a five cent piece should be outlined with chalk. After puddles are identified, they should be filled with “Plexi Patch”, or approved equivalent. Allow patches to cure completely before coatings are applied.

END OF SECTION

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SECTION 32 12 18
SYNTHETIC TRACK SURFACE

PART 1—GENERAL

1.1. RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related Sections include the following:
1. 32 00 00 – Bituminous Concrete Pavement
2. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
3. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
4. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

1.2 DESCRIPTION OF WORK

The following specification and qualifications are for the installation of a new all-weather synthetic running track surface. The specification includes but is not limited to the following:

A. Provide all materials, equipment and labor necessary to complete the work as indicated on the Drawings or as specified herein.

B. Protection of Synthetic Turf Field;

C. Synthetic surface installation;

D. Line Marking.

E. Special Requirements**: Track shall have letters facing the bleachers on both sides of the track with the text "PLYMOUTH SOUTH". Color shall be confirmed with Owner.**

F. **Contractor shall note that items listed above, including bituminous paving base and top course make up Alternate # 1.**

1.3 SUBMITTALS

A. Submit shop drawings and product data on materials and installation procedure to Owner's Representative for approval under provisions of Division 1.

B. Submit current **Certified Track Builder** documentation as provided by the **American Sports Builder Association (ASBA)**.

C. Submit ASBA line striping Certification for Class 4.

D. Submit Certification that Contractor is an Authorized Applicator of the surfacing system.

E. Submit polyurethane binder usage certificate from the manufacturer; stating that all polyurethane materials have been formulated specifically for outdoor track use.

F. Any track surface binders submitted shall be produced specifically for use in running track surfacing construction. Written confirmation of this shall be submitted to the Owner and shall include AASTM or IAAF test results for the track system with the stamped certification from the testing laboratory that performed the published tests. Carboxylated Styrene Butadiene Latex shall not be used in the rubber application procedure.

1. Submit name, contact, telephone number, qualifications and a list of references of track surfacing installations as defined in 1.6 below.

G. Submit to Owner a letter of acceptance of the rubber granules by the binder manufacturer.

H. Submit to the Owner a list per 1.6 A of this specification of existing installations the Contractor has performed including owner representative name, telephone number and surface product used AND line striping completed attesting to the quality and workmanship of the installations.

I. Warranty certificates included in these specifications (including both **Manufacturers** and **Installers** warrantees).

J. Samples:

1. Synthetic track surface not less than 3 by 3 inch for each surface being bid. All samples shall represent the exact surface being bid.

K. Submit name of foreman and a list of previously installed project for owner inspection prior to start of work.

L. Certification Letter: After the installation of the track markings, a licensed Professional Engineer or Registered Land Surveyor shall furnish to the Owner a certification letter, attesting to the accuracy of the track markings and measurements that they meet the specified requirements. This submittal shall also include copies of the computations, calculations and drawings that were used to obtain this verification. The Engineer or Surveyor shall affix their stamp to the drawing and the certificate.

M. Statement of Supervision: Upon completion of the work, submit a written statement signed by the manufacturer stating that the field supervision of the manufacturer's representative was sufficient to insure proper application of the materials, that the work was installed in accordance with the Contract Documents and that the installation is acceptable to the manufacturer.

N. Prior to final acceptance, the Contractor shall submit to the Owner three (3) copies of maintenance manuals, which will include all necessary instructions for the proper care and preventative maintenance of a synthetic track surface.

O. Contractor is to provide certified statement in writing listing the overall quantity of rubber (total pounds of granules or strands) and tack coat/primer; and polyurethane binder delivered to the job site and used in this track resurfacing project. Copy of shipping invoices shall be included with this statement. These documents will be submitted to the Landscape Architect prior to final payment

P. Sustainable Design Submittals:

1. Recycled content: Provide manufacturer's written certification of recycled content as defined in accordance with International Standard ISO 14021–1999, Environmental Labels and Declarations—Self-Declared Environmental Claims (Type II Environmental Labeling). Indicate post-consumer and pre-consumer recycled content and provide documentation certifying products are from recycled sources. (LEED Credit MRc4).

2. Local/regional materials (LEED Credit MRc5):

   a. Indicate location of content of extraction, harvesting, and recovery; indicate the distance between extraction, harvesting, and recovery and the project site. Indicate percentage of product content from qualified locations.

   b. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.

3. Adhesives and Sealants: Include certification of data indicating Volatile Organic Compound (VOC) content of all field-applied adhesives and sealants and compliance with California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda. Submit MSDS highlighting VOC limits. (LEED Credit IEQc4.1).

1.4 PRE-INSTALLATION MEETINGS

A. Prior to the installation of the track system, the Owner and synthetic track surface installer shall meet to establish special requirements, proper sequence and method of installation including method of compaction of all materials to ensure proper installation and drainage of all surfaces. The track surface installer shall sign-off on the bituminous base prior to the surface installation.

B. Prior to line striping, Contractor shall conduct a meeting, which shall include the Owner, the Contractor and the line striper to confirm all track markings.

1.5 REFERENCE STANDARDS

A. Except as otherwise specified herein, the material and construction should be in accordance with the Department of Public Works, Standard Specifications for Highways and Bridges (SSHB) of the Commonwealth of Massachusetts, latest edition, including all addenda.

B. The American Sports Builders Association (ASBA), formerly The United States Tennis Court and Track Builders Association (USTC&TBA).

C. The National Federation of State High School Associations.

D. The Massachusetts Interscholastic Athletic Association.

1.6 QUALITY ASSURANCE

A. Install of track surfacing shall be a current member in good standing with the **American Sports Builders Association** with specific qualifications in building and constructing tennis courts and running tracks. Approved installer of running track surfacing system shall be fully knowledgeable and completely experienced with the manufacture and installation of running track surface systems for outdoor use.

Installer **must** employ a **Certified Track Builder**, as conferred by the **American Sports Builders Association**. Approved manufacturer and installer shall have demonstrated at least ten (10) years experience in the manufacture and successful installation of at least ten (10) complete running track surface system installations in New England.

B. No part of the surfacing installation will be conducted during rainfall or when rain is imminent. After rainfall, sufficient time shall be given to allow the surface to dry thoroughly. Materials are to be only applied when ambient temperature is 50°F and rising.

1.7 GUARANTEE

A. Request, receive and forward to the owner two (2) copies of a written warranty and guarantee from the manufacturer stating that all work executed under this section will be free from defects of material for a period of five (5) years from the date of project completion and that any defects will be remedied on written notice at no additional cost to the owner. This guarantee does not cover items damaged by improper use of vandalism as determined by the owner.

1. The warranty submitted must have the following characteristics:
   a. Must provide full coverage for five (5) years from the date of substantial completion.
   b. Must warrant materials and workmanship.
   c. Warrantee must be provided by both installer and manufacturer and must insure that the materials installed meet or exceed the product specifications.
   d. Must have a provision to either make a cash refund or repair or replace such portions.
   e. Guarantee the availability of replacement material for the synthetic surface system.
2. The contractor shall provide the names of three (3) existing clients for whom significant after the sale service work has been performed or for whom the contractor has performed significant Polyresin Trac Surface Warranty Services.

B. Running Track: finished system shall meet following criteria:

1. Force Reduction: 30 percent to 50 percent, inclusive.
2. Modified Vertical Deformation: 0.6mm to 1.8mm, inclusive.
3. Resistant to scuffing and shedding of granules.

1.8 TESTING

A. The Owner shall reserve the right to submit representative samples of the synthetic track surface to an independent testing lab at any time during the length of the warranty to determine the chemical composition and performance characteristics. Tests will be made to confirm compliance with the project and manufacturer's specification of the track system as submitted by the Contractor and accepted by the Owner.

B. The Owner will be responsible for paying for all initial testing of the synthetic surfacing. If the surface is found to be acceptable, the Owner will bear the cost of replacing the core sample areas in the track surface. Any section of track found not to be in compliance with the project or manufacturer's specifications shall be removed and replaced at the expense of the Contractor. Further testing of the synthetic surfacing, that has been replaced, will be done by an independent testing lab at the direction of

the Owner and at the expense of the Contractor.

C. The samples shall be taken every 1,000 square yards. The sample size shall be approximately 6 by 6 inches. The samples of synthetic surfacing removed from the track for testing shall not be reinstalled. The Contractor shall follow manufacturer's specifications for replacing the surfacing within the core sample areas.

PART 2 PRODUCTS

2.1 SYNTHETIC TRACK SURFACE

A. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is NOT a proprietary specification and it should be noted that "or equivalent" applies to all products denoted herein. It is understood that all manufacturers will have minor variations in configuration, appearance, and product specifications and such minor variations shall not eliminate such manufacturers as an equivalent. It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that are able to supply similar products.

B. The basis of design and acceptable manufacturer of synthetic track surface shall be 13mm Red BSS-100; manufactured by Beynon Sports Surfaces of Hunt Valley, MD; and distributed by Cape & Island Tennis & Track of Pocasset, MA (508) 759-5636, or approved equivalent.

C. All liquid products shall be supplied by one manufacturer..

1. Court Patch Binder shall comply with Specification section 10.14, or approved equivalent.

2. Primer: BEYPRIM, polyurethane-based primer specifically formulated to be compatible with the paved-in-place SBR granules and surfacing material, or approved equivalent.

3. Polyurethane Binder: black mat shall be BEYPUR, and MDI-based single-component, polyurethane binding agent. The binder shall not have a free TDI monomer level above 0.2% and must be solvent free. The binder must be specifically formulated for compatibility with SBR rubber crumb, or approved equivalent.

4. Structural Spray Coating: The spray coating shall be BEYPUR, an MDI-based single-component, moisture cured, 100% solids, and pigmented polyurethane, specifically formulated for compatibility with EPDM granules. The coating shall be the red. Final approval of color by owner. Pigment intergraded in the field shall not be allowed, or approved equivalent.

5. Line Paint: All line and event markings shall be applied by experienced personnel utilizing the manufacturers' recommended pigmented paint compatible with the BSS 100 Track Surfacing material, or approved equivalent.

D. The rubber granules for the BEYPUR structural spray wearing coats shall be EPDM, synthetic rubber containing a minimum 20% EPDM resin, with a specific gravity of 1.5 ± 0.1 g/cm3. The EPDM rubber shall color shall be red.

E. The rubber granules for the base mat shall be recycled SBR rubber, processed and chopped to 1-3mm size, containing less than 1% dust.

F. Water shall be clean, fresh and potable.

PART 3 EXECUTION

3.1 GENERAL

A. Allow asphalt pavement a minimum cure time of 14 days or longer as recommended by manufacturer prior to installation of primer and synthetic surface over new asphalt pavement.

3.2 SUBBASE

A. Track system shall be laid on an approved subbase. The General Contractor shall provide compaction test results of 95% or greater for the installed subbase and asphalt surface. The asphalt cure time is 28 days.

B. The asphalt substrate track surface shall not vary from planned cross slope by more than + .2%, with a maximum lateral slope outside to inside of 1% to 2%, and a maximum slope of 0.1% in any running direction. The finished asphalt shall not vary under a 10' straight edge more than 1/8”.

C. It should be the responsibility of the contractor to flood the surface immediately after the asphalt is capable of handling traffic, but within 24 hours. If, after 20 minutes of drying time, there are birdbaths evident, it shall be the responsibility of the architect, in conjunction with the surfacing contractor to determine the method of correction. No cold tar patching, skin patching or sand mix patching will be acceptable.

D. Any oil spills (hydraulic, diesel, motor oil) must be completely removed, either by chipping out or removing and replacing with new, keyed in asphalt. The minimum depth of any asphalt replacement shall be one inch. The curing time for the asphalt base is 28 days. It shall be the responsibility of the surfacing contractor to determine if the asphalt substrate has cured sufficiently prior to the application of polyurethane surfacing system.

E. It shall be the responsibility of the general contractor to determine if the asphalt substrate meets all design specifications, i.e. cross slopes, planarity and specific project criteria. After all the above conditions are met, the synthetic surfacing contractor must, in writing, accept the planarity of the asphalt receiving base before work can commence.

3.3 EQUIPMENT

A. Track Surfacing System components shall be porcessed and installed by specially designed machinery and equipment. A mechanically operated paver with variable regulated speed and thermostatically controlled screed shall be used in the installation of the base mat. The wearing coruse shall be installed using automatic electronic portioning, which provides continuous mixing and feeding for an accurate, quality controlled installation.

3.4 BASE COURSE

A. The SBR granules and BEYPUR shall be mixed together on site to regulate the ratio/quantity of SBR, not to exceed 82% by weight in the base mat portion of the system. The single component polyurethane binder shall be mixed with the SBR rubber so that a minimum of 20%, by weight, exists in the final mixture. This mixture is then mechanically installed using the paver.

3.5 WEARING COURSE

A. The 0.5 to 1.5 millimeter EPDM granules shall be mixed with BEYPUR, the single-component structural spray coating. The structural spray shall be made in two (2) uniform applications.

3.6 SITE CONDITIONS

A. Installation shall not take place if adjacent or concurrent construction generates excessive dust, abrasives or any other by-product that, in the opinion of the installer, would be harmful to the track material, until completion of such works.

B. Apply Synthetic Track Surfacing in dry weather when pavement and atmospheric temperatures are fifty (50) degrees Fahrenheit or above, and are anticipated to remain above fifty (50) degrees Fahrenheit for twenty-four (24) hours after completing application.

C. The maximum temperature cannot exceed 105 degrees at any point during a 24 hour period.

D. Rain cannot be falling. If there is a threat of rain, work shall cease until dry conditions can be re-established on the track pavement. Work is to proceed only when adequate curing can be guaranteed by the manufacturer.

3.5 LINE MARKING

A. Wait 48 hours after completion of surfacing before applying line marking.

B. Locate and establish all radius points.

C. Establish and set all necessary control points.

D. Layout all lines and markings to within a 1/2'" tolerances.

E. Provide all computations and measurements in an organized form.

F. Establish all locations on the curves using a transit or Theodolite capable of reading direct to 20 seconds.

G. Identify all markings where appropriate by painting the identification directly onto the track surface in 4" letters just below or in front of each mark on the right hand portion of the lane.

H. Paint all of the large 3' high; lane numbers in two (2) colors **(white and blue)**, utilizing shadowed backgrounds.

I. All lines shall receive sufficient paint to assure opacity and uniformity of color.

J. Paints shall be used directly from original containers and shall be thinned only when hot temperatures dictate thinning for smooth applications.

K. Amount of paint used shall be as recommended by the manufacturer.

L. Competent, experienced and fully qualified personnel shall make all measurements.

M. The paint shall be 100% acrylic latex line paint. Line Paint made specifically for the painting of the lines on a running track.

N. The markings shall include all events and marks required or recommended by the National Federation of State High Schools (Massachusetts) and the Massachusetts Interscholastic Athletic Association (MIAA).

3.6 CLEANUP AND MAINTENANCE

A. Upon completion of the work, the contractor shall remove all containers, surplus materials and debris. The site will be left in a clean and orderly manner acceptable to the Owner.

B. Clean entire area daily. All trash and job related debris shall be removed from the site or stored in an approved dumpster at the end of each day's work. The location of any dumpsters shall be coordinated with the school department. Dumpsters shall be covered at all times other than to provide adequate capacity for job related debris at all times. Storage of job related debris in locations other than dumpsters or approved staging areas shall not be permitted. Remove and dispose of all demolition materials, trash and debris except materials specifically designed to remain as property of the Owner in strict accordance with Local, State and Federal laws.

C. References that are submitted in the bid must demonstrate experience of successfully installed, repaired, renovated and guaranteed at least five running track projects for school districts, colleges or universities (public or private), other governmental agencies or private business.

3.7 FIELD QUALITY CONTROL

A. The finished track surface shall be tested for compliance with the above specifications. The following method shall be employed:

1. The Contractor shall conduct 60 thickness tests during the installation.

END OF SECTION

Section 32 13 13

SITE CONCRETE

PART 3 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS, which are hereby, made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work included: Provide all labor, materials, equipment, and transportation necessary to complete the placement of concrete. Such work includes, but is not limited to, the following:

1. Furnishing, placing, curing, finishing and protection of all plain and reinforced concrete work, above and below grade of the Site. Also, include all concrete work necessary to complete the work of other trades.
2. Coordination with all other trades for location of all pipe sleeves, duct openings, electrical boxes and conduits and other devices required by other trades.
3. Prepare program of inspections of all concrete work and perform such tests and inspections.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections.

1. Section 31 00 00, Earthwork for excavation, backfill and compaction requirements.
2. Section 32 00 00, Paving Walkways, Curbing, and Edging for installation of curbing.

3.3 SUBMITTALS

A. Refer to Section 01 33 00 Submittals provisions and procedures.

1. Material Certificates: Provide copies of materials certificates signed by material producer and Contractor, certifying that each material item complies with, or exceeds, specified requirements.
2. Plant mix design for concrete.
3. Submit manufacturer’s literature describing products, installation procedures and routine maintenance.
4. Samples for Verification Purposes: Submit three (3) samples of surface applied polyurethane tactile mat of the kind proposed for use.
5. Shop drawings are required for products specified showing fabrication details; tile surface profile; adhesives; plans of mat placement including joints, and material to be used as well as outlining installation materials and procedure.

1.4 REFERENCE STANDARDS

A. The following standards are applicable to the Work of this Section to the extent referenced herein:

1. Commonwealth of Massachusetts, Massachusetts Highway Department (MHD), Standard Specifications for Highways and bridges, latest English Edition with amendments, hereinafter referred to as the "Standard Specifications." All referenced to method of measurement, basis of payment and payment items in the Standard Specifications are herby deleted. References made to particular Sections or paragraphs in the Standard Specifications shall include all related articles mentioned therein.
2. Commonwealth of Massachusetts, Massachusetts Highway Department, Construction Standards, latest Edition with amendments hereinafter referred to as the "Construction Standards."
3. ASTM: American Society for Testing and Material.
4. AASHTO: American Association of State Highway and Transportation Officials.
5. ACI: American Concrete Institute.
6. All ramps and curb ramps shall comply with American Disabilities Act Accessibility Guidelines and the Massachusetts Architectural Access Board (MAAB).

1.5 TESTING, CONTROL AND INSPECTION

A. The Contractor will retain the services of a qualified independent testing agency, approved by the Architect, to test aggregate and to prepare a mix design for each strength of concrete specified; and shall submit such mix designs and test results to the Architect for approval. Mix designs may also be based on proven current designs accompanied by test results. The costs of all such preliminary services shall be borne by the Contractor.

B. The Owner will retain the services of a concrete testing company to provide concrete sampling and testing.

1. Testing equipment will be provided by and tests performed by the testing laboratory. Upon request by the Architect, the testing laboratory shall provide such auxiliary personnel and services needed to accomplish the testing work.
2. Concrete test cylinder tests shall be taken for each 50 cubic yards of concrete placed, but at least one set for each day of concrete placements.
3. Testing required because of changes requested by the Contractor in materials, sources of materials or mix proportions, and extra testing of concrete or materials because of failure to meet the Specification requirements shall be paid by the Contractor.
4. Concrete shall be sampled and tested for quality control as follows:
   a. Sampling fresh concrete: ASTM C172
   b. Concrete test specimens: ASTM C31
   c. Slump: ASTM C143. – Slump shall be one to three inches, or five to seven inches with Super plasticizer.
   d. Air Content: ASTM C231 – Air content shall be 6% +/- 1%.

e. Compressive strength: ASTM C39 – Concrete shall be 4000 psi at 28 days

f. Unit Weight: ASTM C29

1.6 NOTIFICATION OF RELATED TRADES

A. Notify all other trades responsible for installing chases, electrical handholes, conduit, and other electrical utilities when ready for such installation, and for final checking immediately before concrete is placed. Cooperate with such trades to obtain proper installation.

PART 4 - PRODUCTS

4.2 BOLLARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable.

B. Bollard Construction:

1. Bollard shall be constructed of 6” ID Schedule 40 steel pipe and filled with 3,000 PSI concrete.
2. Bollard shall be capped with 1/4” steel plate welded to pipe and shall be grinded smoth.

C. Steel Finish: Color Coated.

1. Color: As indicated by Concrete Bollard detail on sheet C6.2, Site Details No. 2.

4.3 CONCRETE

A. Portland Cement: ASTM C-150 Type 1: All cement shall be from a single source.

B. Natural Aggregates:

1. Fine Aggregate for Concrete: Shall be natural sand consisting of clean, hard, durable, uncoated particles, conforming to ASTM C33. Organic content shall be determined according to ASTM C40. Allow no frozen or partially frozen aggregate in the mix.
2. Course Aggregate for Concrete: For regular weight concrete use crushed stone or gravel from approved source conforming to ASTM C33. Coarse aggregate shall not contain greater amounts of deleterious material than specified in table III, ASTM C33.

C. Water from approved source, potable, clean and free of oils, salt, alkali, organic matter and other deleterious material.

2.2 DETECTABLE WARNING SYSTEM

A. Description

1. This Section includes Specifications for furnishing and installing Cast In Place Replaceable Detectable Warning Surface Tiles (REP) with an in-line truncated dome pattern, embedded in all curb ramps and walking surfaces at the locations and to the dimensions shown on the Drawings, in accordance with the Contract Documents and as directed by the Engineer.

B. Quality Assurance
1. Provide composite cast-in-place replaceable detectable warning surface tiles as produced by a single manufacturer with a minimum of five years' experience in manufacturing cast in place replaceable detectable warning surface tiles.
2. Installer's Qualifications: Engage an experienced installer certified in writing by the Detectable Warning Surface manufacturer, who has successfully completed Detectable Warning Surface installations similar in material, design, and extent to that indicated for the Contract.
3. Cast in place replaceable detectable warning surface tiles shall meet or exceed the following test criteria using the most current test methods:
   a. Compressive Strength: 28,900 psi minimum, when tested in accordance with ASTM D695.
   b. Flexural Strength: 29,300 psi minimum, when tested in accordance with ASTM D790.
   c. Water Absorption: Not to exceed 0.10%, when tested in accordance with ASTMD570.
   d. Slip Resistance: 1.05 minimum wet and 1.18 dry static coefficient of friction when tested in accordance with ASTM C1028.
   e. Flame Spread: 25 maximum, when tested in accordance with ASTM E84.
   f. Salt and Spray Performance of Detectable Warning Surface: No deterioration or other defects after 200 hours of exposure, when tested in accordance with ASTM-B117.
   g. Chemical Stain Resistance: No reaction to 1% hydrochloric acid, motor oil, calcium chloride, gum, soap solution, bleach, and antifreeze, when tested in accordance with ASTM D543.
   h. Abrasion Resistance: 500 minimum, when tested in accordance with ASTM C501.
   i. Accelerated Weathering of Detectable Warning Surface when tested by ASTM-G155 or ASTM G151 shall exhibit the following result: $\Delta E<5.0$ at 2,000 hours minimum exposure.
   j. Tensile Strength: 11,000 psi minimum, when tested in accordance with ASTM D638.
   k. AASHTO-H20 Load Bearing Test: No Damage at 16,000# loading.
   l. Freeze/Thaw/Heat: No deterioration when tested in accordance with ASTM C 1026.

C. Delivery, Storage, and Handling
1. Cast in place replaceable detectable warning surface tiles shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy wrappings.
2. Storage Facility:
   a. Store tiles in an area that is within an acceptable temperature range (40-90 degrees). In particular, protect sealants from freezing.
   b. Maintain Storage Facility in a clean dry condition to prevent contamination or damage to tiles and incidentals.
   c. Contractor shall provide six (6) replacement detectable warning surface tiles to the Owner as attic stock at the completion of the project.

D. Guarantee
1. Cast in place replaceable detectable warning surface tiles shall be guaranteed in writing for a period of five (5) years from date of Contract's final com-

pletion. The guarantee includes manufacturing defects, breakage, and deformation.

E. Materials
1. Cast in place replaceable detectable warning surface tiles shall be manufactured using a matte finish exterior grade homogeneous glass and carbon reinforced polyester based Sheet Molding Compound (SMC) composite material. Truncated domes must contain fiberglass reinforcement within the truncated dome for superior structural integrity and impact resistance. A matte finish will be required on the Detectable Warning Surface for superior slip resistance performance superior to that offered by a gloss finish.

F. Colors
1. Cast in place replaceable detectable warning surface tiles shall contrast visually with adjacent walking surfaces either light-on-dark, or dark-on-light. Coordinate color selection with Owner prior to furnishing and installing tiles.

2.3 CONCRETE ADA ACCESSIBLE CURB CUTS

A. Contractor shall install concrete ADA accessible curb cuts at all locations shown on plans. Curb cut configurations shall be as detailed on the Drawings.
1. All concrete curb cuts shall be isolated from surrounding concrete pavement when applicable.
2. Curb cuts shall be built with cut curbstone to match concrete curb cut slopes.

B. Curb cuts shall comply with all requirements established by the Architectural Access Board, Commonwealth of Massachusetts, CMR 521.

C. Curb cuts shall not exceed:
1. Cross-slopes at front and back of curb cuts: 1.5% max.
2. Curb cuts: 7.5% max

D. All planes of the finished curb cuts shall be field checked for slopes using a two-foot electronic “smart” level.
1. Curb cuts that do not comply with the slope requirements shall be cut out in their entirety and completely rebuilt.

2.4 CONCRETE RAMPS

A. All ramps to comply with ADA Accessibility Guidelines and MAAB.

B. All ramps shall be sloped no greater than 1:12.

C. Ramps shall have level landings at bottom and top of each ramp and each ramp run. Landings shall have the following features:
1. The landing shall be at least as wide as the ramp run leading to it.
2. The landing length shall be a minimum of 60 in (1525 mm) clear.
3. If ramps change direction at landings, the minimum landing size shall be 60 in by 60 in (1525 mm by 1525 mm).

2.5 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.6 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from steel wire into flat sheets.

B. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

C. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A, plain steel.

D. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

E. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 deformed bars.

F. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 deformed bars.

G. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.

H. Plain-Steel Wire: ASTM A 82/A 82M

I. Deformed-Steel Wire: ASTM A 496/A 496M.

J. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A coated.

K. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.

L. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain-steel bars.

M. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.

N. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

O. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from

steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

P. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

Q. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

R. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

S. Zinc Repair Material: ASTM A 780.

PART 5 - EXECUTION

3.1 CONCRETE BOLLARDS

A. EXAMINATION

1. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. INSTALLATION, GENERAL

1. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
2. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.
3. Install site furnishings level, plumb, true, and [**securely anchored**] [**positioned**] at locations indicated on Drawings.
4. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.
5. Posts Set into Voids in Concrete: Form or core-drill holes for installing posts in concrete to depth recommended in writing by manufacturer of site furnishings and 3/4 inch (19 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with [**nonshrink, nonmetallic grout**] [**or**] [**anchoring cement**], mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.
6. Pipe Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with [**nonshrink, nonmetallic grout**] [**or**] [**anchoring cement**], mixed and placed to comply with anchoring material

manufacturer's written instructions, with top smoothed and shaped to shed water.

3.2 MIXING PROCESS FOR CAST-IN-PLACE CONCRETE

A. Ready-mixed concrete shall be mixed and transported in accordance with specification for Ready-Mixed Concrete" ASTM C94, Alt. No. 3 and ACI Standard 304, "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.

B. The concrete shall be of such consistency and be so spaced and worked that a smooth mortar face will be replaced.

3.3 EMBEDDED ITEMS FOR CAST-IN-PLACE CONCRETE

A. Coordinate the installation of all inserts required by other trades.

3.4 PLACING OF CAST-IN-PLACE CONCRETE

A. Notify the Architect at least 48 hours prior to each placement.

B. Do not place concrete until conduit, catch basin frame and grates, manhole frames and covers, granite curing and other work to receive the concrete have been inspected and approved by the Architect and all other trades concerned.

C. In hot weather all concreting shall be done in accordance with ACI 306, "Recommended Practice for Hot Weather Concreting".

D. In cold weather, all concreting shall be done in accordance with ACI 306, "Recommended Practice for Cold Weather Concreting".

E. Conveying: Concrete shall be handled from the mixer to the place of final deposit as rapidly as practicable by methods that will prevent separation or loss of ingredients and in a manner which will assure that the required quality of the concrete is retained.

F. Depositing: Delivery and placement of concrete shall be programmed so that the time lapse between batching and placement shall not exceed 1-1/2 hours. Concrete shall not be allowed a free fall over 4 feet. Concrete shall be deposited as nearly as practicable in its final position to avoid segregation due to rehandling or flowing.

G. Concrete shall be deposited continuously, in horizontal layers of such thickness (not deeper than 18 inches) that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the Section. Placing shall be carried out at such a rate that the concrete, which is being integrated, with fresh concrete is still plastic. Concrete which ash partially hardened or which ash been contaminated with foreign materials shall not be deposited.

3.5 INSTALLATION OF DETECTABLE WARNING SYSTEM

A. During all concrete pouring and REP Tile installation procedures, ensure adequate safety guidelines are in place and that they are in accordance with the applicable industry and government standards..

B. The physical characteristics of the concrete shall be consistent with the Contract Specifications while maintaining a slump range of 4 - 7 to permit solid placement of the REP Tile. An overly wet mix will cause the REP Tile to float. Under these conditions suitable weights such as 2 concrete blocks or sandbags (25 pounds) shall be placed on each REP Tile.

C. The concrete shall be poured and finished, true and smooth to the required dimensions and slope prior to REP Tile placement.

D. To the maximum extent possible, the REP Tiles shall be oriented such that the rows of in-line truncated domes are parallel with the direction of the ramp. When multiple REP Tiles regardless of size are used, the truncated domes shall be aligned between the detectable warning surface tiles and throughout the entire detectable warning surface installation.

E. The REP Tiles shall be tamped or vibrated into the fresh concrete to ensure that there are no voids or air pockets, and the field level of the detectable warning surface tile is flush to the adjacent concrete surface or as the Drawings indicate to permit proper water drainage and eliminate tripping hazards between adjacent finishes.

F. On Continuous Runs: The Installer shall leave a 1/8” nominal gap between successive Detectable Warning Surface Tiles. As part of the concrete finishing operation, the Installer shall apply ¼” edge treatment around the perimeter of the detectable warning surface tiles to facilitate future replacement of the detectable warning surface tile. A urethane sealant such as Sikaflex 1a or BASF NP1 shall be applied to the edge treatment for a watertight detectable warning surface tile installation.

G. During and after the REP Tile installation and the concrete curing stage, it is imperative that there are no walking, leaning or external forces placed on the REP Tile to rock the REP Tile, causing a void between the underside of the REP Tile and the concrete substrate.

H. Remove protective plastic sheeting from REP Tile within 24 hours of installation of the REP Tile. articularly under hot weather conditions (80 degrees or higher), plastic sheeting will adhere strongly (resulting in difficult removal of same) to detectable warning surface tile when not removed quickly.

I. Clean REP Tiles by method specified by the manufacturer.

3.6 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.7 STEEL REINCORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.

F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.

G. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch (50-mm) overlap of adjacent mats.

End of Section

Section 32 13 14
EXPOSED AGGREGATE CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Massachusetts Highway Department (MHD), Standard Specifications for Highways and Bridges, latest English Edition with amendments, hereinafter referred to as the "Standard Specifications".

C. Massachusetts Highway Department (MHD), Construction Standards, latest Edition with amendments hereinafter referred to as the "Construction Standards".

D. Related Sections: The following Sections contain requirements that relate to this Section:
1. Section 03 00 00 – Cast-In-Place Concrete
2. Section 31 00 00 – Earthwork
3. Section 32 00 00 – Bituminous Paving
4. Section 32 13 13 – Site Concrete
5. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
6. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
7. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

1.2 DESCRIPTION OF WORK

A. This Section includes exterior exposed aggregate concrete paving for the following:
1. Exposed Aggregate walkways and accents at the locations shown on the plans and specified herein.

1.3 SUBMITTALS

A. General: Refer to Section 01 33 00 Submittals provisions and procedures.

B. Provide product data for all materials and items, including reinforcement and forming accessories, aggregates, admixtures, joint systems, curing compounds and sealants.

C. Design mixes and Material Certificates as per Section 32 13 13 "Submittals"

D. The Contractor shall submit a one (1) gallon sample of the aggregate for review and approval by the Landscape Architect.

E. The Contractor shall fabricate in the field one sample of the exposed aggregate concrete paving in a single pour measuring 20' long x 6'wide x 4" thick for approval by the Landscape

Architect. The sample shall demonstrate the final surface finish, texture, each joint type and color that will be provided uniformly throughout the project.

F. If the sample is approved, it may become part of the final work and shall be the basis of workmanship for all other exposed aggregate concrete paving.

G. Provide all qualification data listed in Section 1.4 of this specification

H. Sustainable Design Submittals:

1. Recycled content: Provide manufacturer's written certification of recycled content as defined in accordance with International Standard ISO 14021–1999, Environmental Labels and Declarations—Self-Declared Environmental Claims (Type II Environmental Labeling). Indicate post-consumer and pre-consumer recycled content and provide documentation certifying products are from recycled sources. (LEED Credit MRc4).

2. Local/regional materials (LEED Credit MRc5):

   a. Indicate location of content of extraction, harvesting, and recovery; indicate the distance between extraction, harvesting, and recovery and the project site. Indicate percentage of product content from qualified locations.

   b. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.

3. Adhesives and Sealants: Include certification of data indicating Volatile Organic Compound (VOC) content of all field-applied adhesives and sealants and compliance with California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda. Submit MSDS highlighting VOC limits. (LEED Credit IEQc4.1).

1.4 QUALITY ASSURANCE

A. Qualifications: The foreman and labors shall be thoroughly trained and experienced in the skills required to complete exposed aggregate flatwork, be completely familiar with the design and application of the work, be present at all times during the work and perform the work. The foreman and labors shall have no less than 5 years minimum proven experience in the required paving techniques and desired results. Submit list of installations, indicating location, Owner, Architect/Engineer, date of installation, Contractor, and setting bed, for approval by the Architect.

B. Refer to Section 32 13 13 for Reference Standards.

C. Refer to Section 32 13 13 for Testing, Control and Inspection.

D. Refer to Section 32 13 13 for Notification of Related Trades.

E. Concrete Testing Service: Engage a qualified independent testing agency to perform materials evaluation tests and to design concrete mixes.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other acceptable panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
   1. Use flexible or curved forms for curves of a 100-foot or less radius.

B. Form Release Agent: Provide commercial formulation form-release agent with a maximum of 350 g/L volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.2 REINFORCING MATERIALS

A. Reinforcing Steel Bars: Shall be newly rolled billet steel conforming to ASTM A615 (Grade 60 unless noted). Bars shall be bent cold. Reinforcing bars being welded shall conform to ASTM A706, Grade 60.

B. Joint Dowel Bars: Stainless steel bars, ASTM A955. Cut bars true to length with ends square and free of burrs.

C. Welded Wire Mesh shall be welded plain cold-drawn steel wire fabric, ASTM A 185 and shall be supplied in sheets.

D. Supports for Reinforcement: Chairs, spacers, dowel bar supports and other devices for spacing, supporting, and fastening reinforcing bars, welded wire fabric, and dowels in place. Use wire bar-type supports complying with CRSI specifications.
   1. Use supports with sand plates or horizontal runners where base material will not support chair legs. Concrete bricks may be used to support reinforced steel where application allows.

E. Synthetic Reinforcement: Shall be collated fibrillated 100 percent virgin homopolymer polypropylene fibrous bundles used for secondary reinforcement for flat work conforming to ASTM C1116.

2.3 CONCRETE MATERIALS

A. The Contractor shall insure that the final appearance of the sidewalks is consistent throughout the whole project. Any differences in color, texture, or finish will not be accepted by the Landscape Architect.
   1. Any portion of sidewalk or walkway that does not match the color, texture, or finish of previously constructed sidewalks will be removed and replaced with a sidewalk that matches the recently poured sidewalks at the expense of the Contractor.

B. Portland Cement: ASTM C 150, Type I for resistance to salt and ice melt chemicals.
   1. Use one brand of cement throughout Project.

C. Aggregate: Shall be hard, sound, durable, **native, angular** and free of all deleterious materials and staining qualities.
   1. Aggregate shall be thoroughly washed so that it is free of dust, dirt, and clay particles.
   2. All Aggregate shall be from same source throughout project.
   3. Aggregate - Aggregate size shall be 3/8” – 1/2” nominal.

4. Aggregate shall be in a color range of warm tones: tan, brown, buff.

D. Water: Shall be from an approved source, potable, clean and free of oils, salts, alkali, organic matter and other deleterious material.

2.4 ADMIXTURES

A. Provide concrete admixtures that contain not more than 0.1 percent chloride ions.

B. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

C. Water-Reducing Admixture: ASTM C 494, C494M, Type D.

D. High-Range Water-Reducing Admixture: ASTM C 494, C494M, Type F

E. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.

F. Water-Reducing and Retarding Admixture: ASTM C 494, C494M, Type D.

2.5 CURING MATERIALS

A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9oz. per sq. yd., complying with AASHTO M 182, Class 2.

B. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.
1. Waterproof paper.
2. Polyethylene film.
3. White burlap-polyethylene sheet.

C. Clear Solvent-Borne Liquid Membrane-Forming Curing Compound: ASTM C 309, Type I, Class A or B, wax free.

D. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type I, Class B.
1. Provide material that has a maximum volatile organic compound (VOC) rating of 350g/L.

E. Evaporation Control: Monomolecular film-forming compound applied to exposed concrete lab surfaces for temporary protection from rapid moisture loss.

F. Contractor shall use the same manufacturer for the curing compound, retarder and sealer.

2.8 CHEMICAL SURFACE RETARDER

A. Chemical Surface Retarder must be a water-soluble, liquid-set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete depth of 1/8 to ¼ inch. The chemical surface retarder must be approved by the Engineer before beginning construction of sidewalks.
B. Contractor shall use the same manufacturer for the curing compound, retarder and sealer.

2.9 GROUT

A. Non-Shrink Cement Grout shall be ready-to-use non-metallic aggregate product requiring only the addition of water.

2.10 CONCRETE SEALER

A. Sealer shall be a water-based acrylic low sheen product that is non-yellowing and has good blush resistance such as Everclear VOX by Euclid Chemicals.

B. The following manufacturer's are also acceptable:
1. BASF
2. WR Meadows
3. Or equivalent

C. Contractor shall use the same manufacturer for the curing compound, retarder and sealer.

2.11 JOINTS AND SEALANTS

A. Preformed polyethylene foam expansion joint material with backer rods. Self-Leveling Joint Sealant shall be Type HL2 per section 079200, 2.2, G.

PART 3 - EXECUTION

3.1 CONCRETE MIX

A. Prepare design mixes for each type and strength of normal-weight concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use a qualified independent testing agency for preparing and reporting proposed mix designs.
1. Do not use the Owner's field quality-control testing agency as the independent testing agency.

B. Proportion mixes according to ACI 211.1 and ACI 301 to provide normal-weight concrete with the following properties:
1. Compressive Strength (28-Day), ASTM C39: 4000 psi.
2. Maximum Water-Cement Ratio at Point of Placement: 0.45.
3. Slump Limit at Point of Placement, ASTM C143: 3 inches maximum.
   a. Slump limit for concrete containing high-range water-reducing admixture (superplasticizer): Not more than 8 inches after adding admixture to site-verified 2-to-3-inch slump concrete.

C. Add air-entraining admixture, ASTM C231, at manufacturer's prescribed rate to result in concrete at point of placement having an air content as follows with a tolerance of plus or minus 1-1/2 percent:
1. Air Content: 5.5 percent for 1-1/2-inch maximum aggregate.
2. Air Content: 6.0 percent for 1-inch maximum aggregate.
3. Air Content: 6.0 percent for 3/4-inch maximum aggregate.
4. Air Content: 7.0 percent for 1/2-inch maximum aggregate.
5. Air Content: 2.5 to 4.5 percent.

D. Addition of Synthetic Reinforcement:
1. Fiber reinforcement shall be added to the batched concrete at the batch plant. Unless otherwise noted on the drawings or elsewhere herein fibers shall be added to the mix at the ratio of 1.0 pound of fiber per batched yard of concrete.
2. Fibers shall be added to the mix prior to transport.

E. Adjustment to Concrete Mixes: Contractor may request to the Architect Mix design adjustments when characteristics of materials, project conditions, weather, test results, or other circumstances warrant.

3.2 CONCRETE MIXING

A. Ready-Mixed Concrete shall be mixed and transported in accordance with specification for Ready-Mixed Concrete ASTM C94, Alt. No. 3 and ACI Standard 304, “Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.

3.3 SURFACE PREPARATION

A. Proof-roll prepared subbase surface to check for unstable areas and verify need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving. **Note: Contractor shall confirm that all compaction requirements of the base course have been met.**

B. Remove loose material from compacted subbase surface immediately before placing concrete.

3.4 INSTALLATION OF EMEDDED ITEMS

A. Conform to requirements of ACI 318, Chapter 6 “Conduits and Pipes Embedded in Concrete”, and as specified below.

B. Installation if inserts required by other trades shall be coordinated with or shall be installed prior to placing of reinforcing steel. All inserts to be supplied by the respective trade and installed by the General Contractor.

3.5 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for paving to required lines, grades, and elevations. Install forms to allow continuous progress of work and so that forms can remain in place at least 24 hours after concrete placement.

B. Check completed formwork and screeds for grade and alignment to following tolerances:
1. Top of Forms: Not more than 1/8 inch in 10 feet.
2. Vertical Face on Longitudinal Axis: Not more than 1/4 inch in 10 feet.

C. Clean forms after each use and coat with form release agent ensuring separation from concrete without damage.

3.6 JOINTS

A. General: Construct contraction, construction, and expansion joints true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to the centerline, unless indicated otherwise on the Plans.
1. When joining existing paving, place transverse joints to align with previously placed joints, unless indicated otherwise on the Plans.

B. Contraction or Control Joints: Provide weakened-plane contraction or control joints, sectioning concrete into areas 4-feet on center, or as shown on Drawings. Construct

contraction or control joints for a depth equal to at least 1/3 of the concrete thickness, as follows:

1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into hardened concrete when cutting action will not tear, abrade, or otherwise damage surface and before development of random contraction cracks.
2. Joints perpendicular to walls may be less than required depth within 6 inches of the wall, and may stop 2 inches from the wall. Wash slurry from concrete to avoid staining of slab.
3. If a wet saw is used, all surrounding surfaces need to be washed to remove all slurry and fines caused by the wet saw.

C. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than ½ hour, unless paving terminates at expansion joints.

1. Provide preformed galvanized steel or plastic keyway-section forms or bulkhead forms with keys, unless indicated otherwise. Embed keys at least 1-1/2 inches into concrete.
2. Continue reinforcement across construction/control joints unless indicated otherwise. Do not continue reinforcement through sides of strip paving unless indicated.
3. Provide tie bars at sides of paving strips where indicated.
4. Self-Leveling Joint Sealant shall be applied in construction joint after perforated portion of polyethylene foam joint filler is removed. Sealant color shall match concrete color and **Shall Not be Bright White.**

D. Expansion Joints: Form expansion joints material with backer rods at abutting concrete curbs, catch basins, manholes, inlets, buildings, structures, walks, other fixed objects, and as indicated on the plans.

1. Locate expansion joints at intervals of 20 feet, unless indicated otherwise on the Plans.
2. Extend polyethylene foam joint fillers to full width and depth of joint.
3. Furnish polyethylene foam joint fillers in one-piece lengths. Where more than one length is required, lace or clip polyethylene foam joint filler sections together.
4. After concrete is poured, top perforated portion of polyethylene foam joint filler shall be removed.
5. Self-Leveling Joint Sealant shall be applied in expansion joint after perforated portion of polyethylene foam joint filler is removed. Sealant color shall match concrete color and **Shall Not be Bright White.**

E. Install stainless steel dowels at joints where indicated on the plans. Lubricate one half of dowel length to prevent concrete bonding to one side of joint.

3.7 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcing before placing concrete. Do not place concrete on surfaces that are frozen.

C. Moisten subbase to provide a uniform dampened condition at the time concrete is placed.

Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.

D. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
   1. When concrete placing is interrupted for more than 1/2 hour, place a construction joint.

E. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

F. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete complying with ACI 309R.
   1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcing, dowels, and joint devices.

G. Screed paved surfaces with a straightedge and strike off. Use bull floats or darbies to form a smooth surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces prior to beginning finishing operations.
   1. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.
   2. Remove and replace portions of bottom layer of concrete that have been placed more than 15 minutes without being covered by top layer or use bonding agent if acceptable to Architect.

H. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

I. Cold-Weather Placement: Comply with provisions of ACI 306R and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures. **Note to Contractor that exposed aggregate concrete flatwork shall not be done under extreme cold conditions.**
   1. When air temperature has fallen to or is expected to fall below 40 deg F (4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
   2. Do not use frozen materials or materials containing ice or snow.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.

J. Hot-Weather Placement: Comply with provisions of ACI 305R and as follows when hot weather conditions exist.
   1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 deg F (32 deg C). Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
   2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel

temperature will not exceed the ambient air temperature immediately before embedding in concrete.

3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.8 EXPOSED AGGREGATE FINISH

A. In accordance with manufacturer's recommendations, a set retarder shall be sprayed or brushed over the concrete surface. The rate of the application of the retarder shall be sufficient so that the depth of mortar paste removed, on exposing the aggregate, shall be no more that 1/8-inch. The surface treated with retarder shall be protected by covering with polyethylene sheeting or paper to prevent drying out. The retarded mortar paste shall be removed within 12 hours after placement. The use of a set retarder may be waived by the Architect, provided assurance is guaranteed that all of the exposed aggregate surface finish is uniform in exposure and appearance.

B. The exposing of the aggregate shall be accomplished by simultaneously brushing and hosing of the mortar with water. Care shall be exercised not to overexpose or dislodge the aggregate.

C. After the exposing of aggregate has been completed, the residue of the work shall be removed and legally disposed of, and any existing surface or facility splattered or stained shall be thoroughly cleaned.

3.9 CONCRETE PROTECTION, CURING AND SEALING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with the recommendations of ACI 306R for cold weather protection and ACI 305R for hot weather protection during curing.

B. Evaporation Control: In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before floating.

C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than 7 days with the following materials:
   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with a 12-inch lap over adjacent absorptive covers.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall

within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.

E. Sealer: Apply uniformly in 2 coats in continuous operations according to manufacturer's written instructions. Allow first coat to dry before applying second coat.
   1. Begin sealing dry surface no sooner than 14 days after concrete placement.
   2. 6 months after initial sealing, the Contractor shall clean and reseal all exposed aggregate surfaces according to this specification.

3.10 FIELD QUALITY CONTROL TESTING

A. Employ a qualified independent testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement as follows:

B. The Owner will employ a qualified testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement. Sampling and testing for quality control may include the following:
   1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
      a. Slump: ASTM C 143; one test at point of placement for each compressive-strength test but no less than one test for each day's pour of each type of concrete. Additional tests will be required when concrete consistency changes.
      b. Air Content: ASTM C 231, pressure method; one test for each compressive-strength test but no less than one test for each day's pour of each type of air-entrained concrete.
      c. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.
      d. Compression Test Specimens: ASTM C 31; one set of four standard cylinders for each compressive-strength test, unless directed otherwise. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.
      e. Compressive-Strength Tests: ASTM C 39; one set for each day's pour of each concrete class exceeding 5 cu. yd. but less than 25 cu. yd., plus one set for each additional 50 cu. yd. Test one specimen at 7 days, test two specimens at 28 days, and retain one specimen in reserve for later testing if required.

   2. When frequency of testing will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.
   3. When total quantity of a given class of concrete is less than 50 cu. yd., Architect may waive strength testing if adequate evidence of satisfactory strength is provided.
   4. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
   5. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi.

C. Test results will be reported in writing to Architect, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing agency, concrete type and class, location of concrete batch in paving, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day and 28-day tests.

D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.

E. Additional Tests: The testing agency will make additional tests of the concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met, as directed by Architect. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

3.11 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective, or does not meet the requirements of this Section.

B. Drill test cores where directed by Architect when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with Portland Cement Concrete bonded to paving with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep concrete paving not more than 2 days prior to date scheduled for Substantial Completion inspections.

E. Six (6) months after initial sealing and installation, the Contractor shall clean and reseal all exposed aggregate surfaces according to this specification.

END OF SECTION

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Section 32 14 00
UNIT PAVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related Sections include the following:
1. Section 31 00 00 - Earthwork

1.2 DESCRIPTION OF WORK

A. This Section includes the following:
1. Unit Paver Type 'A'

1.3 SUBMITTALS

A. Product Data: For materials other than water and aggregates.
1. All Unit Paver Types shall be submitted to the Landscape Architect.

B. Sieve Analyses: For aggregate, washed sand and setting-bed materials, according to ASTM C 136.

C. Samples for Initial Selection: For the following:
1. Each type of unit paver indicated.
2. Polymeric joint sand

D. Samples for Verification:
1. Three (3) Full-size paver units of each type of unit paver indicated, in the color to be installed.
2. Joint materials for sidewalks and crosswalks.
3. Compatibility and Adhesion Test Reports: From latex-additive manufacturer for mortar and grout containing latex additives.

E. Provide all qualification data listed in Section 1.4 of this specification.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from one source with resources to provide materials and products of consistent quality in appearance and physical properties.

B. Preconstruction Compatibility and Adhesion Testing: Submit to latex-additive manufacturer, for testing indicated below, samples of paving materials that will contact or affect mortar and grout that contain latex additives.
1. Use manufacturer's standard test methods to determine whether mortar and grout materials will obtain optimum adhesion with, and will be non staining to, installed pavers and other materials constituting paver installation.

C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion. Mockups shall be at least 6'x6' square.

D. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Store liquids in tightly closed containers protected from freezing.

E. Store asphalt cement and other bituminous materials in tightly closed containers.

1.6 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

PART 2 – PRODUCTS

2.1 Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is NOT a proprietary specification and it should be noted that "or equivalent" applies to all products denoted herein. It is understood that all manufacturers will have minor variations in configuration, appearance, and product specifications and such minor variations shall not eliminate such manufacturers as an equivalent. It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that are able to supply similar products.

2.2 UNIT PAVER TYPE 'A'

A. Unit Paver will be a concrete paver, manufactured by Unilock or approved equivalent. Type: Town Hall Paver. Size shall be approximately 9.75"x3.9"x 2.73" deep. Color shall be the "3 Color Blend". **Contractor shall refer to the plans for details of base.**

B. Acceptable Manufacturers shall include:
   a. Unilock
   b. Belden Brick
   c. Pine Hall
   d. Approved Equivalent.

B. Pavers shall meet the minimum material and physical properties set forth in ASTM C 936, Standard Specification for Interlocking Concrete Paving Units. Efflorescence shall not be a cause for rejection.

1. Average compressive strength 8000 psi (55MPa) with no individual unit under 7,200 psi (50 MPa).
2. Average absorption of 5% with no unit greater than 7% when tested according to ASTM C 140.
3. Resistance to 50 freeze-thaw cycles, when tested according to ASTM C 67, with no breakage greater than 1.0% loss in dry weight of any individual unit. This test method shall be conducted not more than 12 months prior to delivery of units.

2.3 SETTING-BED MATERIALS

A. Sand Gravel Base: Sound, crushed stone or gravel complying with requirements in Section 31 00 00 - Earthwork.

B. Sand for Leveling Course: Sound, sharp, washed, natural sand complying with gradation requirements in ASTM C 33 for fine aggregate.

C. Geotextile fabric shall be Geotextile 1 conforming to the specification in Section 31 00 00 – Earthwork.

D. Sand for Paver Joints: Polymeric Sand, manufactured sand with polymer binders and calibrated aggregate size with 100 percent passing No. 16 sieve.
   1. Color: to match adjacent paving.

2.4 FLATNESS TOLERANCES

A. A 4-foot dimension in any direction on the surface shall determine variation from true plane, or flat surfaces. The maximum variation from true plane shall not exceed 1/8 inch per 12 inches or 1/8 of the specified joint width, whichever is greater.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.
   2 Where pavers are to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations. Examine areas where waterproofing system is turned up or flashed against vertical surfaces and horizontal waterproofing. Proceed with installation only after protection is in place.

3.2 PREPARATION

A. Remove substances from base surface and/or concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

B. Clean concrete substrates to remove dirt, dust, debris, and loose particles.

C. Proof-roll prepared subgrade according to requirements in Division 2 Section "Earthwork" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive base course for unit pavers.

3.3 INSTALLATION GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be visible in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

D. Exercise care in handling coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. Remove coating from bonding surfaces before setting brick.

E. Tolerances: Do not exceed 1/32-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 10 feet from level, or indicated slope, for finished surface of paving.

F. Expansion and Control Joints: Where applicable provide for sealant-filled joints at locations and of widths indicated. Provide foam filler as backing for sealant-filled joints, if indicated. Color of sealant shall match adjacent pavers.

3.4 SETTING-BED APPLICATIONS

A. Compact soil subgrade uniformly to at least 95 percent of ASTM D 698 laboratory density.

B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting and replace with compacted backfill or fill.

C. Place pavers on sand leveling course, laid over fully cured concrete base, compact by tamping with plate vibrator, and screed to depth indicated.

D. Where applicable core drill 2” holes in concrete rigid base for drainage as indicated in plans.

E. Place drainage geotextile over drill holes after filling with crushed peastone.

F. Place leveling course and screed to a thickness of 1 to 1-1/2 inches, taking care of that moisture content remains constant and density is loose and constant until pavers are set and compacted.

G. Set pavers with a minimum joint width of 1/16 inch and a maximum of 1/8 inch, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch with pieces cut to fit from full-size unit pavers.
   1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.

H. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf compaction force at 80 to 90 Hz. Perform at least three passes across paving with vibrator. Vibrate under the following conditions:
   1. After edge pavers are installed and there is a completed surface or before surface is exposed to rain.
   2. Before ending each day's work, fully compact installed concrete pavers to within 36 inches of the laying face. Cover pavers that have not been compacted, and leveling course on which pavers have not been placed, with non-staining plastic sheets to protect them from rain.

I. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.

J. Do not allow traffic on installed pavers until sand has been vibrated into joints.

K. Repeat joint-filling process 30 days later.

3.5 REPAIRING, POINTING, AND CLEANING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Pointing: When applicable, when tooling of joints, enlarge voids or holes and completely fill with grout. Point up joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

C. Cleaning: Remove excess sand or grout from exposed paver surfaces; wash and scrub clean.
   1. Remove temporary protective coating from brick pavers as recommended by protective coating manufacturer and as acceptable to unit paver and grout manufacturer. Trap and remove coating to prevent it from clogging drains.

END OF SECTION

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Section 32 17 23

PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within SECTION 01 - GENERAL REQUIREMENTS, which are hereby, made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. This Section shall include: Labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. The work covered under this Section of the Specifications includes furnishing all labor, equipment, appliances and materials, and performing all operations in connection with the furnishing and placing of the pavement marking as indicated on the Drawings and as herein specified.

B. Related Sections include the following:

1. Section 31 00 00 "Earthwork" for soil materials, excavating, backfilling, and site grading.
2. Section 32 00 00 Bituminous Concrete Pavement, Curbing and Edging for placement of vertical granite curbing and paving of roadways and walkways.

1.3 SUBMITTALS

A. Refer to Section 01 33 00 – SUBMITTAL PROCEDURES for submittal provisions and procedures.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified pavement marking installer whose work has resulted in successful establishment pavement markings.

1. Installer’s Field Supervisions: Require Installer to maintain an experienced full-time supervisor on Project Site when work is in progress.

1.5 REFERENCE STANDARDS

A. All work shall conform to the Commonwealth of Massachusetts, Massachusetts Highway Department, Standard Specifications for Highways and Bridges, hereinafter referred to as the Standard Specification, section 840 and 860, and Engineering Directive Dated June 16, 2005.

1.6 LIABILITY FOR DAMAGES

A. The Contractor shall be liable for all damage to existing signs prior or during removal and resetting.

PART 2 - MATERIALS

2.1 Final Pavement Markings within MassDOT Right-of-way shall be thermoplastic, conforming to Massachusetts Standard Specifications.

2.2 Final Pavement Markings onsite shall be epoxy resin, conforming to Plymouth and Massachusetts Standard Specifications.

2.3 Pavement markings shall be “white” or “yellow” in color, unless otherwise noted on Drawings.

2.4 General pavement marking delineation for parking stalls shall measure 4 inches in width. All other pavement-marking widths are shown in detail on the plans.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of pavement markings shall be in accordance with the Massachusetts Standard Specifications and Manufacturer’s Requirements.

B. Pavement marking should be installed within 48 hours after the final pavement installation.

3.2 INSPECTION

A. All materials and each part or detail of the work shall be subject to observation by the Architect. The Architect shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the contractor as is required to make a complete and detailed inspection, (such assistance may include furnishing labor, tools, and equipment, at no expense to the Architect).

B. Any work done or materials used without authorization by the Architect may be ordered removed and replaced at the Contractor’s expense. The Contractor shall furnish written information to the Architect stating the original sources of supply of the materials manufactured away from the actual site of the work. In order to insure a proper time sequence for required inspection and approval this information shall be furnished at least two weeks (or as otherwise directed by the Architect) in advance of the incorporation in the work of any such materials.

C. For the purpose of observing work that affects their respective properties, inspectors for the municipalities, public agencies and the utility companies shall be permitted access to the work, but all official orders and directives to the Contractor will be issued by the Architect.

D. The observation of the work shall not relieve the Contractor of any of his obligations to fulfill the terms of the Contract as herein prescribed by the plans and specifications.

E. Failure to reject any defective work or materials shall not in any way prevent later rejection when such defect is discovered, or obligate the Architect to make final acceptance.

End of Section

Section 32 17 24

SIGNS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within SECTION 01 - GENERAL REQUIREMENTS that are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. This Section shall include: Labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. The work covered under this Section of the Specifications includes furnishing all plant, labor, equipment, appliances and materials, and performing all operations in connection with the furnishing and placing of the pavement marking as indicated on the drawings and as herein specified.
2. Furnishing and installing appropriate signs, of the type specified and at the locations shown on the Drawings or as indicated by the Architect in conformity with these specifications.
3. Install handicap-parking signs as indicated on the drawing and all other parking instructional signs and gates as specified by the manufacturer's installation instructions.

B. Related Sections include the following:

1. Section 31 00 00 "Earthwork" for soil materials, excavating, backfilling, and site grading.
2. Section 32 00 00 Bituminous Concrete Pavement Curbing and Edging for placement of vertical granite curbing and paving of roadways and walkways.

1.3 SUBMITTALS

A. Refer to Section 01 33 00 – Submittals Procedures for submittal provisions and procedures.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified sign installer whose work has resulted in successful establishment signs.

1. Installer's Field Supervisions: Require Installer to maintain an experienced full-time supervisor on Project Site when work is in progress.

1.5 REFERENCE STANDARDS

A. All work shall conform to the Commonwealth of Massachusetts, Massachusetts Highway Department, Standard Specifications for Highways and Bridges, hereinafter referred to as the Standard Specification, section 840 and 860. Excavation and backfill shall conform to the Standard Specification, section 140.

B. Traffic Sign work under this item shall conform to the relevant provisions of the MHD Standard Specifications, and the Manual on Uniform Traffic Control Devices.

1.6 LIABILITY FOR DAMAGES

A. The Contractor shall be liable for all damage to existing signs prior or during removal and resetting.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Traffic Signs

1. Materials for all sign panels shall be aluminum panels Type A-1 with high intensity Type III reflective sheeting in accordance with the relevant provisions of Section 828 Traffic Signs of the "Standard Specifications."
2. Sign supports and foundations shall be in accordance with the details and MUTCD as indicated on the Contract Drawings and Section 840 of the "Standard Specifications."

PART 3 - EXECUTION

3.1 INSPECTION

A. All materials and each part or detail of the work shall be subject to inspection by the Architect. The Architect shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the contractor as is required to make a complete and detailed inspection, (such assistance may include furnishing labor, tools, and equipment, at no expense to the Owner).

B. If the Architect so requests, the Contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the specifications. Should the work thus exposed or examine prove acceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed will be paid for as extra work; but should the work so exposed or examined prove unacceptable, the uncovering or removing and the replacing of the covering or making good of the parts removed, will be at the Contractor's expense.

C. Any work done or materials used without authorization by the Architect may be ordered removed and replaced at the Contractor's expense. The Contractor shall furnish written information to the Architect stating the original sources of supply of the materials manufactured away from the actual site of the work. In order to insure a proper time sequence for required inspection and approval this information shall be furnished at least two weeks (or as otherwise directed by the Architect) in advance of the incorporation in the work of any such materials.

D. For the purpose of observing work that affects their respective properties, inspectors for the municipalities, public agencies and the utility companies shall be permitted access to the work, but all official orders and directives to the Contractor will be issued by the Architect.

E. The inspection of the work shall not relieve the Contractor of any of his obligations to fulfill the terms of the Contract as herein prescribed by the plans and specifications.

F. Failure to reject any defective work or materials shall not in any way prevent later rejection when such defect is discovered, or obligate the Architect to make final acceptance.

G. The Contractor shall give prior notice to the Architect when work on the various items is to be performed by him or his Subcontractors. If work is suspended on any time, prior notice shall be given to the Architect before resumption of the work.

3.2 EXECUTION

A. Sign fabrication and erection shall be in accordance with the relevant requirements of Sections 828 and 840 of the “Standard Specifications’ and the “Construction Standards.”

1. Post foundations, except in ledge, shall be excavated by an auger to the next lines of the outside diameter of the footing without disturbing the soil around or below the excavation.

B. The Contractor shall mark the location of all on-site signs and shall obtain the approval of the Architect before any signs are installed.

C. Signs located in areas subject to pedestrian traffic shall be mounted with a minimum 7-foot clearance to the bottom of the sign. The Contractor shall install the sign types and posts at the locations shown on the Contract Drawings.

D. Signs shall be mounted at right angles to the direction of, and facing, the traffic they are intended to serve. The sign panel shall be located a minimum of one foot from the curb line or edge of pavement.

End of Section

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SECTION 32 18 16
PLAYGROUND PROTECTIVE SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
1. Section 31 00 00 – Earthwork
2. Section 11 68 10 – Play Structure Equipment
3. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
4. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
5. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

1.2 DESCRIPTION OF WORK

A. This Section includes the following:
1. Play Surfacing
2. No tile surfacing will be accepted only poured in place surfacing will be approved.

1.3 DEFINITIONS

A. Critical Height: Standard measure of shock attenuation. According to CPSC No. 325, this means "the fall height below which a life-threatening head injury would not be expected to occur."

B. SBR: Styrene-butadiene rubber.

1.4 PERFORMANCE REQUIREMENTS

A. Impact Attenuation: According to ASTM F 1292.

B. Accessibility of Surface Systems: According to ASTM F 1951.

C. Minimum Characteristics for Organic Loose-Fill Surfaces: According to ASTM F 2075.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show the following:
   1. Installation details for all surfacing materials and accessories.
   2. Colors and pattern of surfaces.
   3. Location of wear mats in organic loose-fill surfaces.
   4. Location of drainage accessories.

C. Samples for Initial Selection: For each type of playground surface system indicated.
   1. Include similar Samples of playground surface system and accessories involving color selection.

D. Samples for Verification: For each type of playground surface system indicated.
   1. Minimum 1-quart loose-fill surface sealed in a container.

E. Qualification Data:
   1. Manufacturer approved installer certification
   2. Testing agency qualifications

F. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
   1. Unitary synthetic seamless surface.
   2. Organic loose-fill surface.
   3. Inorganic loose-fill surface.

G. Material Certificates: For each playground surface system product, signed by manufacturers.

H. Field quality-control test reports.

I. Maintenance Data: For playground surface system to include in maintenance manuals.

J. Warranty: Special warranty specified in this Section.

K. Sustainable Design Submittals:
   1. Recycled content: Provide manufacturer's written certification of recycled content as defined in accordance with International Standard ISO 14021–1999, Environmental Labels and Declarations—Self-Declared Environmental Claims (Type II Environmental Labeling). Indicate post-consumer and pre-consumer recycled content and provide documentation certifying products are from recycled sources. (LEED Credit MRc4).
   2. Local/regional materials (LEED Credit MRc5):
      a. Indicate location of content of extraction, harvesting, and recovery; indicate the distance between extraction, harvesting, and recovery and the project site. Indicate percentage of product content from qualified locations.
      b. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
   3. Adhesives and Sealants: Include certification of data indicating Volatile Organic Compound (VOC) content of all field-applied adhesives and sealants and compliance with California Department of Health Services

Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda. Submit MSDS highlighting VOC limits. (LEED Credit IEQc4.1).

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Testing Agency Qualifications: An independent agency qualified according to ANSI Z34.1 for testing indicated.

C. Source Limitations: Obtain playground surface system materials, including primers and binders, through one source from a single manufacturer.
   1. Provide secondary materials including adhesives, primers, geosynthetics, and repair materials of type and from source recommended by manufacturer of playground surface system materials.

1.7 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit playground surface system installation to be performed according to manufacturers' written instructions and warranty requirements.

B. When the ambient air temperature is forecasted to change greater than 30 degrees over a 24 hour period pouring of the base coat and top coat shall not occur.

1.8 COORDINATION

A. Coordinate installation of playground surface systems with installation of playground equipment specified in Section 11 68 10 if applicable.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of playground surface system that fails in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Reduction in impact attenuation.
      b. Deterioration of surface and other materials beyond normal weathering.
   2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In Part 2 Article 2.3 where titles introduce lists, the following requirements apply to product selection:
   1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
   2. Products: Subject to compliance with requirements, provide one of the products specified.
   3. Basis-of-Design Product: The design for each product is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 CRUSHED STONE BASE

A. Crushed stone base shall be a graded, granular, non-frost susceptible, free-drainage material, consisting of either durable stone and coarse sand or of blast furnace slag, stone, and gravel blends practically free from loam and clay, and which can be readily compacted to form a stable, permeable, foundation, graded as follows:

Sieve Size	% Passing by Weight
1 in.	90-100
5/8 in.	50-80
1/4 in.	30-50
No. 4	15-35
No. 8	10-30
No. 30	3-5
No. 200	0-3

2.3 PLAY SURFACE

A. Seamless Surface: Dual-density, poured-in-place system with wearing course over cushion course. Provide thickness for each layer as shown on the Plans, tested for impact attenuation according to ASTM F 1292 and for accessibility according to ASTM F 1951.
   1. Products:
      a. Surface America Incorporated; Poured-in-Place (preferred).
      b. Child Safe Products, Inc.; Safety Surface.
      c. GameTime; GT Impax Poured.
      d. No Fault Industries, Inc.; SAF DEK.
      e. Safe Guard Surfacing Corp.; Poured in Place.
      f. SpectraTurf, Inc.; Spectra Pour.

   2. Top Surface: EPDM rubber particles and polyurethane.
   3. Base Material: Formulation of SBR particles and polyurethane, site mixed and applied.

4. Binder: Weather-resistant, UV-stabilized, flexible, non-hardening, 100 percent solids polyurethane complying with requirements of authorities having jurisdiction for nontoxic and low VOC content.
5. Critical Height: 40 inches.
6. Overall Thickness: Not less than what is needed to meet critical height indicated - Two inches**.**
7. Primer/Adhesive: Manufacturer's standard primer and weather-resistant, moisture-cured polyurethane adhesive suitable for unit, substrate, and location indicated.
8. Top Surface Colors to be selected by owner.
9. Filler/Sealant: Manufacturer's standard clear silicone or polyurethane filler/sealant suitable for exterior use.

B. Leveling and Patching Material: Portland cement-based grout or epoxy- or polyurethane-based formulation suitable for exterior use and approved by playground surface system manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

A. General: Prepare substrates to receive surfacing products according to playground surface system manufacturer's written instructions. Verify that substrates are sound and without high spots, ridges, holes, and depressions.

B. Subgrade: Provide sound surface free of laitance, efflorescence, curing compounds, and other contaminants incompatible with playground surface system.
1. Repair unsatisfactory surfaces and fill holes and depressions.
2. Subgrade shall be graded and compacted to a 95% Standard Proctor Compaction.

C. Crushed Stone Base: The Contractor shall compact the stone base to 95% Standard Proctor Compaction. The base shall be graded to a tolerance of ¼" in 10 feet. The Contractor shall obtain approval from the Owner's Representative prior to installing the playground surface system.

3.2 INSTALLATION, GENERAL

A. General: Comply with playground surface system manufacturer's written installation instructions. Install playground surface system over area and in thickness indicated on the drawings.

B. If the ambient air temperature is forecasted to fluctuate greater than 30 degrees in a 24 hour period, the Contractor shall halt pouring of the play surfacing until the fluctuation in ambient air temperature is less than 30 degrees.

3.3 INSTALLATION OF SEAMLESS PLAYGROUND SURFACE SYSTEMS

A. Seamless Surface: Mix and apply components of playground surface system according to manufacturer's written instructions.
1. Substrate Primer: Apply over prepared substrate at manufacturer's standard spreading rate for type of substrate.

2. Cushion Course: Spread evenly over primed substrate to form a uniform layer applied at manufacturer's standard spreading rate in one continuous operation, with a minimum of cold joints.
3. Intercoat Primer: Over cured cushion course, apply primer at manufacturer's standard spreading rate.
4. Wearing Course: Spread over primed base course to form a uniform layer applied at manufacturer's standard spreading rate in one continuous operation and, except where color changes, with no cold joints. Finish surface to produce manufacturer's standard wearing-surface texture.
5. Edge Treatment: As indicated on drawings.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Services: Testing and inspecting of completed applications of playground surface system shall take place according to ASTM F 1292.

C. Remove and replace applications of playground surface system where test results indicate that it does not comply with requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with requirements.

3.5 PROTECTION

A. Seamless Systems: Contractor shall be responsible for protecting the play surfacing from any type of traffic over system for a minimum of 48 hours after installation.

END OF SECTION

Section 32 18 17
SPECIAL SURFACES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related sections include the following:
1. Section 31 00 00 – Earthwork
2. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
3. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
4. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

1.2 DESCRIPTION OF WORK

A. The principle work of this section includes, but may not be limited to:
1. Skinned Infield Surface
2. Batter's Box and Mound Clay
3. Stone Sand Surface
4. Sand for Jumping Pits
5. River Stone

1.3 SUBMITTALS

A. Laboratory test results for tests identified in Part 2 - Products.

B. Representative samples of materials identified in Part 2 Products.

C. Sustainable Design Submittals:

1. Recycled content: Provide manufacturer's written certification of recycled content as defined in accordance with International Standard ISO 14021–1999, Environmental Labels and Declarations—Self-Declared Environmental Claims (Type II Environmental Labeling). Indicate post-consumer and pre-consumer recycled content and provide documentation certifying products are from recycled sources. (LEED Credit MRc4).

2. Local/regional materials (LEED Credit MRc5):

a. Indicate location of content of extraction, harvesting, and recovery; indicate the distance between extraction, harvesting, and recovery and the project site. Indicate percentage of product content from qualified locations.

b. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.

3. Adhesives and Sealants: Include certification of data indicating Volatile Organic Compound (VOC) content of all field-applied adhesives and sealants and compliance with California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda. Submit MSDS highlighting VOC limits. (LEED Credit IEQc4.1).

1.4 MINIMUM REQUIREMENTS

A. Infield Mix:

1. The successful bidder shall meet the following minimum requirements in order to be considered for installation of the athletic fields. **All requirements listed in 1.4 MINIMUM REQUIREMENTS shall be documented and submitted to the Architect for approval prior to commencement of any athletic field work.**
2. Selected installer must have installed fields greater than three (3) years old of similar materials and design. **Documentation of this shall be furnished per 1.4, A above.**
3. Selected installer must install athletic fields using his/her own crews, subcontracting of installation work will not be allowed.
4. Selected installer must have a minimum of five (5) baseball infields at over 25,000 square feet each installed in the Northeast United States of similar construction. **A list of these installations with owner's name and phone number shall be furnished per 1.3, A above.**
5. Selected installer must have a minimum of five (5) years' experience in the installation of athletic fields. The crew foreman shall have installed a minimum of five (5) similar installations. **A list of previous projects installed by foreman shall be furnished per 1.3, A above.**

1.5 QUALITY ASSURANCE

A. The Skinned Surface Mix and Stone Sand Surface shall be selected and defined by the criteria established under Part 2 – products and Owner's testing. The mixes will be evaluated using the criteria set forth in Part 2.

B. Pay close attention to special surfaces. Surface materials vary within the ball field areas. Any uncertainty of surface material must be brought to the attention of the Owner's Representative for clarification. The Contractor will be responsible for assuring that all special surfaces are applied in the area specified.

C. The approved installer shall meet with the Site Contractor and General Contractor to review the following:
   1. Review the entire system including subgrade, base, utilities, and drainage to ensure all components are complimentary.
   2. Installation of the athletic field shall be done only after excavation and construction work which might injure it has been complete. Damage caused during construction shall be repaired prior to acceptance.

D. Do not make substitutions without written approval. If specified materials are not available, obtain approval for substitution from the Architect and Owner's Representative.

E. Material: Quality control samples shall be completed at a rate of one per 250 tons of material delivered to the jobsite. All tests shall be conducted by the same lab as the original sample.

PART 2 - PRODUCTS

2.1 Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is NOT a proprietary specification and it should be noted that "or equivalent" applies to all products denoted herein. It is understood that all manufacturers will have minor variations in configuration, appearance, and product specifications and such minor variations shall not eliminate such manufacturers as an equivalent. It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that are able to supply similar products.

2.2 SKINNED INFIELD SURFACE

A. Infield mix shall be mechanically mixed offsite in a controlled environment to provide a thorough mixing of the sand and clay components to exact specifications as described in section 2.2-B of this specification.

B. The skinned area soil mix shall be a composite soil of washed mason-type sand, silt, and clay, reddish brown to tan in color and conform to the following physical properties:
   1. Total sand content shall be seventy percent (70%) to seventy five percent (75%).
   2. The combined amount of sand retained on the medium, coarse and very coarse sieves shall be greater than fifty percent (50%).
   3. The combined amount of silt and clay shall be twenty five percent (25%) to thirty percent (30%).
   4. The ratio of silt-to-clay shall be 0.5-1.0.
   5. No particles greater than 3mm.
   6. Equal to or lesser than five percent (5%) of particles shall be retained on the two millimeters (2mm).

C. Soil Additives:
   1. Pre-emergent weed control for skinned infield areas. Incorporate Simazine (Trade names Princept, Simazine, Sim-trol) or equivalent in top two inches

(2”) of skinned infield mix according to manufacturer's recommendation for local soil conditions.

2. Turface, a calcined clay sports field conditioner shall be added as a top dressing to the skinned infield areas, or equivalent. Application shall be done to manufacturer’s recommendations.

D. Excess Materials

1. Provide the owner or owners’ authorized representative with a 10-ton stockpile of material for future use.

2.3 MOUND AND BATTER’S BOX CLAY

A. Infield mix shall be mechanically mixed offsite in a controlled environment to provide a thorough mixing of the sand and clay components to exact specifications as described in section 2.4-B of this specification.

B. Pitching mound and batter’s box clay is clean, dry clay mixed with washed masonry type sand resulting in a weed-free mix that is reddish brown in color possessing the following physical properties:

1. Total sand content shall be fifteen percent (15%) to twenty eight percent (28%).
2. The overall clay content shall be greater than thirty percent (30%).
3. The ratio of silt-to clay shall be 0.75-1.25.

C. Excess Materials

1. Provide the owner or owners’ authorized representative with a 1-ton pallet of material for future use.

2.4 STONE SAND SURFACE

A. Stone Sand - Blue-gray, granite-type coarse stone sand conforming to the following gradation requirements:

Sieve Size	Percent Passing
3/8"	100%
#4	96 - 100
#8	80 - 100
#16	50 - 80
#30	20 - 60
#50	10 - 30
#100	0 - 10

B. Steel Edging - Steel edging shall be 1/4”x5” in 16 foot sections with 0.25 Average thickness. Color shall be powder coated Black. Edging shall be manufactured with an interlocking system with stake punch-outs fabricated in each strip. Stakes shall be steel and 15 inches in length.

C. Geotextile fabric shall be Geotextile 1 conforming to the specification in Section 31 00 00 – Earthwork.

D. Sand Gravel Base: Sound, crushed stone or gravel complying with requirements in Section 31 00 00 - Earthwork.

2.5 SAND FOR JUMPING PITS

A. Sand for jumping pits shall be clean, washed mason sand conforming to the following gradation requirements:

Sieve Size	Percent Passing
1/4"	100%
#4	100%
#8	95 –100%
#16	70 - 100%
#30	40 – 75%
#50	10 – 35%
#100	2 – 15%
#200	0 – 5%

B. Geotextile fabric shall be Geotextile 1 and 2 conforming to the specification in Section 31 00 00 – Earthwork.

B. Sand Gravel Base: Sound, crushed stone or gravel complying with requirements in Section 31 00 00 - Earthwork.

2.6 RIVER STONE

A. River Stone shall be 1 ½”- 3” rounded , smooth stone, color shall be tan beige range, contractor to submit a 5 gallon container sample with source indicated

PART 3 - EXECUTION

3.1 SKINNED INFIELD SURFACE

A. Ball field infield areas which are to become skinned shall be excavated to the required depth. Excavated material shall be deposited of in the proper manner.

B. Spread base gravel uniformly over subgrade to the depth indicated on the plans and as specified in Section 31 00 00 - Earthwork. Gravel shall be graded and compacted to produce smooth non-yielding surface.

1. Skinned infield area soil mix shall then be distributed over gravel layer to the depth indicated on the plans required to achieve finish grade.
2. Place material in lifts of two (2) to three (3) inches and lightly compact until an optimum compaction between eight five (85) and ninety (90) percent is achieved on a standard proctor test (ASTM D689-07).
3. Scarify between lifts to ensure bonding between lifts.
4. Wet down the area with surface spray of clean water until area appears to be saturated but workable. Within twenty-four (24) hours, roll entire surface with a roller weighing a minimum of two (2) tons. Additional mix shall be added eliminate depressions or uneven surface. Skinned surface

to be flush with sodded or seeded surface, except in construction of pitcher's mound.

5. Materials shall be finished graded with a laser device that allows accuracy of quarter inch (¼”) in ten feet (10’).
6. Add Turface as per manufacturer’s recommendations for quantity and installation.

3.2 MOUND AND BATTER’S BOX CLAY

A. Pitcher’s Mound and Batter’s Box areas which are to become skinned shall be excavated to the required depth. Excavated material shall be deposited of in the proper manner. Subgrade to be compacted to ninety percent (90%) compaction or greater.

B. Spread base gravel uniformly over subgrade to the depth indicated on the plans and as specified in Section 31 00 00 - Earthwork. Gravel shall be graded and compacted to produce smooth non-yielding surface. Gravel layer to be compacted to ninety percent (90%) compaction or greater.

1. Skinned infield area soil mix shall then be distributed over gravel layer to the depth indicated on the plans required to achieve finish grade.
2. Place material in lifts of two (2) to three (3) inches and lightly compact until an optimum compaction between eight five (85) and ninety (90) percent is achieved on a standard proctor test (ASTM D689-07).
3. Scarify between lifts to ensure bonding between lifts.
4. Wet down the area with surface spray of clean water until area appears to be saturated but workable. Within twenty-four (24) hours, roll entire surface with a roller weighing a minimum of two (2) tons. Additional mix shall be added eliminate depressions or uneven surface. Skinned surface to be flush with sodded or seeded surface, except in construction of pitcher's mound.
5. Materials shall be finished graded with a laser device that allows accuracy of quarter inch (¼”) in ten feet (10’).
6. Add Turface as per manufacturer’s recommendations for quantity and installation.

3.3 STONE SAND SURFACE

A. Areas indicated on the plans which are to receive stone sand surface shall be excavated to the required depth. Excavated material shall be deposited of in the proper manner.

B. Spread base gravel uniformly over subgrade to the depth indicated on the plans and as specified in Section 31 00 00 – Earthwork. Gravel shall be graded and compacted to produce smooth non-yielding surface.

C. Define edges of stone sand surface adjacent to grass or landscaped areas with steel edging, staked in place and set flush to finish grade. All radii and curves shall have smooth curvilinear alignment where as indicated on the plans.

D. Deliver, dump, spread and compact stone sand to conform to the lines and grades shown on the plans.

E. Compaction shall continue until the surface is even and true to the proposed lines and grades indicated on the plans.

F. Stone sand shall not be placed if it is excessively moist and unable to be satisfactorily spread.

G. Stone sand shall be graded to a true even surface to the proposed lines and grades shown on the plans.

H. Compaction of the stone sand and any adjoining embankment material shall be done simultaneously so that the respective materials will be confined substantially to the indicated lines.

I. Apply pre-emergent weed control prior to final rolling. Granular weed control shall be incorporated into top 2" of surface mix by light raking in accordance with manufacturer's recommendations.

3.4 SAND FOR JUMPING PITS

A. Areas indicated on the plans which are to receive sand shall be excavated to the required depth. Excavated material shall be deposited of in the proper manner.

B. Concrete curbing shall be formed and installed to the lines and grades indicated on the plans.

C. Geotextiles, drainage and sand gravel base shall be installed to the depths indicated on the plans and fastened.

D. Sand shall be installed to the final grades and dimensions indicated on the plans.

END OF SECTION

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Section 32 31 14
BLACK VINYL CHAIN LINK FENCING AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related sections include the following:
1. Section 03 00 00 - Cast in Place Concrete
2. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
3. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
4. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.
5. Section 11 68 00 – PLAYFIELD EQUIPMENT AND STRUCTURES: Backstop of Baseball and Softball.

1.2 DESCRIPTION OF WORK

A. Provide all materials, equipment and labor necessary to complete the work as indicated on the drawings or as specified herein.

B. The principal work of this section includes, but may not be limited to, the following:
1. Installation of fences, gates, framework, fabric, and accessories.
2. Excavation for post bases.

1.3 REFERENCES

A. ASTM Standards:
1. A392 – Zinc coated fence fabric (Class –1)
2. A491 – Aluminum Coated (Table 3)
3. F668 – PVC Coating (Class - 2a)
4. F934 – Color Black

B. Federal Standard (FS) RR-F-191 - Fencing, Wire and Post, Metal.

1.4 QUALITY ASSURANCE

A. Installation: ASTM F567

B. Qualifications: The foreman and laborers shall be thoroughly trained and

experienced in the skills required to complete fence and gate, be completely familiar with the design and application of the work, be present at all times during the work and perform the work. The foreman shall have no less than 5 years minimum proven experience in the required installation techniques and desired results. Submit list of installations, indicating location, Owner, Architect/Engineer, date of installation, Contractor, and setting bed, for approval by the Architect.

1.5 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division 01. Submit shop drawings for fence and gates and for all of their components.

B. Include layout, spacing of components, accessories, fittings, anchorages, and schedule of components.

C. Submit manufacturer's installation instructions under provisions of Division 01.

D. Under provisions of Division 01, submit sample of fence fabric finish, color and gauges. Sample size to be 6" x 12" minimum.

E. Sustainable Design Submittals:

1. Recycled content: Provide manufacturer’s written certification of recycled content as defined in accordance with International Standard ISO 14021–1999, Environmental Labels and Declarations—Self-Declared Environmental Claims (Type II Environmental Labeling). Indicate post-consumer and pre-consumer recycled content and provide documentation certifying products are from recycled sources. (LEED Credit MRc4).

2. Local/regional materials (LEED Credit MRc5):

a. Indicate location of content of extraction, harvesting, and recovery; indicate the distance between extraction, harvesting, and recovery and the project site. Indicate percentage of product content from qualified locations.

b. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.

3. Adhesives and Sealants: Include certification of data indicating Volatile Organic Compound (VOC) content of all field-applied adhesives and sealants and compliance with California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda. Submit MSDS highlighting VOC limits. (LEED Credit IEQc4.1).

PART 2 – PRODUCTS

2.1 GENERAL

A. Fabric, posts, gate frames, braces, rails, stretcher bars, truss rods, and tension wire shall be of steel. Gate hinges, post caps and stretcher bar bands shall be of steel, malleable iron, ductile iron, or equal except that post tops and rails ends may be of aluminum. The manufacturer shall supply a notarized mill certification that all materials used have been tested and fully comply with the guidelines specified herein.

B. Temporary Construction Fence shall be 6' ht chain link fence. Powder coating or painting is NOT required.

2.2 FRAMEWORK AND POSTS

A. Framework and posts shall be Type 2 round post, steel pipe cold-formed and welded per ASTM F1043, Group IC, with a minimum yield strength of 50,000 psi. The external zinc coating shall be Type B, zinc with polymer film, 0.90 oz/sq. ft. minimum zinc coating with a chromate conversion and a verifiable polymer film. The internal coating shall be Type B, zinc 0.90 oz./sq.ft. minimum or Type D, zinc pigmented, 81% nominal coating with 0.30 mils minimum thickness. Gate framework joints shall be welded and coated in accordance with Practice A780, employing zinc-rich paint.

B. Framework and posts shall be sized as follows:
   1. End, Corner, and Pull Post. Galvanized steel, minimum pipe sizes and weights as follows:
      a. Up to 6-foot fabric height: 2.375 – inch OD pipe, 3.12 lbs/lin. Ft. minimum.
      b. 7 and 8-foot fabric heights: 2.875-inch OD pipe, 4.64-lbs/lin. Ft. minimum.
      c. Maximum spacing 10'-0" On Center.
      d. 10-foot to 12-foot heights: 4-inch OD pipe, 6.56 lb/linear foot.
   2. Line Posts. Galvanized steel, minimum pipe sizes and weights as follows:
      a. Up to 6-foot fabric height: 1.90-inch OD steel pipe, 2.28-lbs./lin. Ft. minimum.
      b. 7 and 8- foot fabric height: 2.375-inch OD steel pipe, 3.12 lbs./lin. Ft. minimum
      c. Maximum Spacing 10'-0" On Center.
      d. 10-foot to 12-foot heights: 2.875-inch OD pipe, 4.64 lb/linear foot.
   3. Gate Posts. Galvanized steel, nominal gate widths, minimum pipe sizes and weights as follows:
      a. Up to and including 6 feet height with up to 4 foot gate leaves: 2.375 OD pipe minimum.
      b. Up to and including 6 feet height with over 4 foot up to 10 foot gate leaves: 2.875 inch OD pipe minimum.
      c. Up to and including 6 feet height with over 10 feet up to 18 foot gate leaves: 4" OD pipe minimum.

d. Over 6 feet up to 12 feet height with up to 6 foot gate leaves: 2.875" OD pipe minimum.
e. Over 6 feet up to 12 feet height with over 6 feet up to 12 foot gate leaves: 4" OD pipe minimum.
f. Over 6 feet up to 12 feet height with over 12 feet up to 18 foot gate leaves: 6.625" OD pipe minimum.

4. Rails (Top, middle, and bottom rails): galvanized steel, manufacturer's longest lengths joined by seven (7") long sleeves, rail shall run continuously along top of fence. Bottom rail shall be joined at line posts with boulevard clamps. Minimum pipe sizes and weights as follows:
   a. 1.66-inch OD pipe, 1.84 lbs. /lin. Ft. minimum.

2.3 FITTINGS

A. All fittings to be PVC thermally fused color coated having a minimum thickness of 0.006" per ASTM F626. PVC color to match fabric and framework. Moveable parts, nuts and bolts to be field coated with PVC liquid touch up after installation.

1. Couplings: Expansion type, approximately six inches (6") long, install one sleeve for each 500 foot run. Standard couplings are installed at each rail end to form one continuous top rail.
2. Attaching Devices: Provide fittings for attaching top rail securely to each gate corner pull and end post.
3. Sleeves: Galvanized steel pipe not less than six inches (6") long and with inside diameter not less than ½ inch greater than outside diameter of the post pipe. Provide steel plate closure welded to bottom of sleeve of width and length not less than one inch (1") greater than outside diameter of sleeve.
4. Post Brace assembly: Manufacturer's standard adjustable braces at end of gateposts and at both sides of corner and pull posts. Provide horizontal brace located at mid-height of fabric. Use same material as top rail for brace and truss to line posts with 3/8 inch diameter galvanized steel truss rods and adjustable tightener.
5. Post Caps: Galvanized steel, weather-tight closure cap for each tubular post. Furnish caps with openings to permit passages of top rail.
6. Rail ends: Galvanized pressed steel per ASTM F626, for connection of rails to post using a brace band.
7. Tension Bars: galvanized steel, one-piece lengths equal to full height of fabric, with minimum cross-section of 3/16 inch x ¾ inch per ASTM F626. Provide tension bar for each gate and end post, and two for each corner and pull post. Stretcher Bar Bands shall be manufacturer's standards.
8. Gate Cross-Bracing: 3/8 inch diameter galvanized steel truss rods and adjustable tightener.
9. Wire ties: 9 gauge galvanized steel tie wire for attachment of fabric to line posts and rails. Pre-formed hog ring ties to be 9 gauge galvanized steel or aluminum for attachment of fabric to tension wire. Tie wire and hog rings PVC coated and in compliance with ASTM F626. Color to match fabric color.
10. Truss rod assembly: Galvanized steel minimum 5/16" diameter truss rod with pressed steel tightener, in accordance with ASTM F626.
11. Carriage bolts and nuts: Galvanized of commercial quality

2.4 FABRIC

A. All general site fence fabric shall consist of No. 9 gauge (0.148 inch core), 2-inch diamond mesh except for the following: **Six (6) gauge wire for backstop fencing; Eleven (11) gauge wire, 1 ¾" diamond mesh for Tennis Court Fencing. 1" diamond mesh for fence along western property line. All fabric shall receive top and bottom knuckled selvage.** Public side of fabric shall be installed in accordance with the owner's directions. Tennis fabric shall be installed on the court side. The height of the fabric shall be one piece.
   1. Galvanized/Aluminum Coated Fabric: All materials used shall conform to the requirements of ASTM A 392 Class 2, or ASTM A491. Except aluminum alloy items, shall conform to ASTM-B211, B221 and B429.
   2. Polyvinyl Chloride (PVC) Coated Fabric: fence fabric shall be zinc coated in accordance ASTM A392 Class 1 or aluminum-coated in accordance with ASTM A 491 (Table 3). PVC coating shall be applied in accordance with ASTM F668 Class 2a. The color of the fabric shall be black and in accordance with ASTM F934.

2.5 SWING GATES

A. Fabricate chain link swing gates in accordance with ASTM F900. Gate frame to be of welded construction. Weld areas to be protected with zinc-rich paint per ASTM A780 then over coated with liquid PVC to match frame. The gate frame members are to be spaced no greater than 8' 0" apart horizontally or vertically. Exterior members to be 1.900" OD pipe, interior members when required shall be 1.660" OD pipe. Framing and chain link fabric shall match specification of fence system. Fabric shall be stretched tightly and secured to vertical outer frame members using tension bar and tension bands spaced 12" on center and tied to the horizontal and interior members using 9 gauge galvanized steel ties.

B. Hinges, hot dip galvanized pressed steel or malleable iron, structurally capable of supporting gate leaf and allow opening and closing without binding. Non-lift-off type hinge design shall permit gate to swing 180 degrees.

C. Latch: Galvanized forked type capable of retaining gate in closed position and have provision for padlock. Latch shall permit operation from either side of gate.

D. Double gates: Provide galvanized drop rod with center gate stop pipe or receiver to secure inactive leaf in the closed position. Provide galvanized pressed steel locking latch, requiring one padlock for locking both gate leaves, accessible from either side.

E. Keeper to secure open leafs: Provide galvanized gate hold back keeper for each gate leaf over 5' wide. Gate keeper shall consist of mechanical device for securing free end of gate when in full open position.

F. Latch, hinges, moveable parts may be field coated with liquid PVC.

2.6 CHAIN LINK INTERNAL TRACK ALUMINUM CANTILEVER SLIDE GATE

A. Aluminum cantilever slide gates shall be of the internal roller design per ASTM F1184 Type II Class 2. Cantilever slide gate to be constructed of PVC color

coated ASTM B221 aluminum members welded and designed for maximum structural integrity. Vertical external and internal members minimum 2” square spaced maximum 8’-0” on center. Gates having fabric greater than 8’-0” in height require a horizontal member. The top horizontal member shall be a one-piece precision extruded structural member having an integral enclosed track. Bottom horizontal member to be minimum 2” x 4”. Adjustable diagonal trusses shall be installed in each gate panel to transfer the alternating forces as the gate slides. The gate opening portion shall be filled with chain link fabric stretched taut and secured to the frame members. Chain link fabric shall match the fence system specification. The overall gate structure shall be a minimum of 40% larger than the gate opening to support the cantilevered portion of the gate in the closed position with minimum deflection per ASTM F1184. The minimum 40% back frame does not require fence fabric. Single leaf cantilever design for openings larger than 30’-0” up to 40’-0” shall be fabricated by welding together two horizontal top structural/track members creating a dual track system. Single track gates up to 30’-0” opening require two support posts and two internal truck assemblies. Dual track gates over 30’-0” up to 40’-0” require two sets of dual posts and four internal truck assemblies.

B. Internal truck assemblies shall be capable of swiveling to accommodate gate movement and ensure full contact of the four support wheels and two guide wheels to the internal track surface. The galvanized steel truck assembly post bracket, truck assembly vertical support axle as well as the support wheels shall be designed to handle static and dynamic forces required to support and operate the gate. The truck assembly, support axle and internal wheels shall be comprised of stainless steel or galvanized steel components.

C. Galvanized steel bottom guide roller brackets containing two 3” rubber wheels shall be supplied to keep the bottom of the gate plumb and in proper alignment.

D. Single gates shall be supplied with a galvanized steel latch mechanism capable of securing the gate with a padlock accessible from either side. Double gates to have galvanized drop rod to hold inactive leaf and a latch mechanism capable of securing the gate with a padlock accessible from either side. Provide drop rod stop pipe or receiver to engage center drop rod.

E. Cantilever gate posts shall be 4” OD PVC coated. Single leaf cantilevers up to 30’-0” require three 4” OD posts, dual track single leaf cantilevers over 30’-0” up to 40’-0” require two sets of pre-fabricated dual 4” OD support posts and a 4” OD latch post. The gate is supported in the center of the dual posts.

2.7 POST SETTING MATERIALS

A. Concrete: As specified in Section 03 30 00.

B. Drive Anchors: Galvanized ASTM A36 steel drive anchor angle blades, 1.25” x1.25” x 30“ long secured to post with a pressed steel galvanized shoe clamp.

PART 3 – EXECUTION

3.1 FENCE INSTALLATION:

A. Install new fabric, as indicated on drawings; accessories in accordance with ASTM F567.

B. Provide dimensions as shown and space line posts at intervals indicated.

C. Excavation: Excavate holes for concrete with vertical sides in cylindrical form.

D. Setting Posts:
1. Remove loose and foreign materials from sides and bottom of holes, and moisten soil prior to placing concrete.
2. Center and align posts.
3. Place concrete around posts in a continuous pour, and vibrate or tamp for consolidation.
4. Check each post for vertical and top alignment, and hold in position during placement.
5. Trowel tops of footings, and slope or dome to direct water away from posts.
6. Keep exposed concrete surfaces moist for at least seven (7) days after placement.

E. Concrete Strength:
1. Allow concrete to attain at least 75 percent of its minimum 28 day strength before rails, tension wire, and fabric are installed.
2. Contractor shall not, in any case, install such items in less than seven (7) days after placement of concrete.
3. Contractor shall not stretch and tension fabric and wire until concrete has attained its full design strength.
4. Provide top rail through line post tops and splice with six inch (6”) long rail sleeves.

F. Chain link fence shall have continuous top and bottom rails. Top and bottom edge of fence fabric shall have knuckled edges. Fabric shall be stretched uniformly taunt, true to line and grade and complete in all details. Install tension bars at corners.

G. All chain link fence fabric shall be fastened on the outside of the posts unless directed otherwise by the Owner or otherwise indicated in this specification. The fabric shall be stretched and securely fastened to the posts, and between posts the top and bottom of the fabric shall be fastened to end and corner posts with tension bars and stretcher bars bands shall be spaced at one (1) foot intervals.

H. All fabric shall be aligned so that top row of the fabric mesh is tied to the top rail twelve inches (12”) on center and so that the bottom of the fabric mesh stand two inches (2”) maximum above finish grade or as indicated on plans, and that the bottom row of the fabric mesh is tied to the bottom rail every twelve inches (12”) on center. When applicable, all fabric shall be tied to the middle rail at twelve inches (12”) on center.

I. All fabric shall be fastened to all line posts and horizontal rails with 0.020” thickness, 200/300 series stainless steel ½” wide bands, with a minimum breaking strength of 850 lbs., ½” band capacity ear-lokt design buckles to be

manufactured with 0.050" thick material, 201/301 series stainless steel. All bands shall be pulled tight and raw ends of steel bands shall be secured in buckle by folding ear tabs around steel bands as per manufacturer's recommended installation procedure. No sharp edges shall protrude from band-it buckles. Band will be PVC coated, color to match fabric and framework.

J. Perimeter Fencing and Gates: Install fabric 1-inch above finished grade.

K. Touch up any nicks or scratches of the PVC color coating with liquid PVC paint.

L. Touch up any nicks or scratches on the posts or rails with a manufacturers approved paint.

3.2 GATE INSTALLATION

A. Install gates plumb, level, and secure for full opening without interference. Install ground-set items in concrete for anchorage, as recommended by fence manufacturer. Adjust hardware for smooth operation and lubricate where necessary.

END OF SECTION

Section 32 31 19
ORNAMENTAL FENCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related Sections include the following:
1. 03 30 00 - Cast-in-Place Concrete
2. 31 00 00 - Earthwork
3. 32 13 13 – Site Concrete
4. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
5. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
6. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

1.2 DESCRIPTION OF WORK

A. Furnish labor, materials and equipment to include ornamental fencing for the referenced project.

1.3 SUBMITTALS

A. Changes in specification are only upon written approval by Owner.

B. Shop Drawings: Shall consist of dimensions, sizes, full layout based on site conditions, finishes and post foundations.

C. Product Data: Manufacturer's certification indicating material compliance and installation.

D. Samples: Color selections for polyester powder coated finishes. If requested, samples of fence components delivered to Owner.

E. Sustainable Design Submittals:

1. Recycled content: Provide manufacturer's written certification of recycled content as defined in accordance with International Standard ISO 14021–1999, Environmental Labels and Declarations—Self-Declared Environmental Claims (Type II Environmental Labeling). Indicate post-consumer and pre-consumer recycled content and provide documentation certifying products are from recycled sources. (LEED Credit MRc4).

2. Local/regional materials (LEED Credit MRc5):

   a. Indicate location of content of extraction, harvesting, and recovery; indicate the distance between extraction, harvesting, and recovery and the project site. Indicate percentage of product content from qualified locations.

   b. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.

3. Adhesives and Sealants: Include certification of data indicating Volatile Organic Compound (VOC) content of all field-applied adhesives and sealants and compliance with California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda. Submit MSDS highlighting VOC limits. (LEED Credit IEQc4.1).

1.4 QUALITY ASSURANCE

A. Qualifications: The foreman and laborers shall be thoroughly trained and experienced in the skills required to complete fence installation, be completely familiar with the design and application of the work, be present at all times during the work and perform the work. The foreman shall have no less than 5 years minimum proven experience in the required installation techniques and desired results. Submit list of installations, indicating location, Owner, Architect/Engineer, date of installation, Contractor, and setting bed, for approval by the Architect.

PART 2 - PRODUCTS

2.1 Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is NOT a proprietary specification and it should be noted that "or equivalent" applies to all products denoted herein. It is understood that all manufacturers will have minor variations in configuration, appearance, and product specifications and such minor variations shall not eliminate such manufacturers as an equivalent. It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that are able to supply similar products.

2.2 ORNAMENTAL FENCE

A. Ornamental Fence shall be Powder Coated Black Steel and shall have 3 (three) rails at a minimum 1 3/8" sq. Pickets shall be a minimum of ¾" sq. Posts shall be a minimum of 2" sq. Post caps shall be flat style and constructed of aluminum or steel to form a weather-tight closure. All posts, caps, and fence panels shall be polyester coated individually after fabrication to thoroughly coat all surfaces for additional corrosion protection. All components shall enter a 5 stage in line cleaning process to prepare the galvanized surfaces for complete adhesion of the finish coat. Components shall be given a TGIC polyester resin powder coating applied by the electrostatic spray process to 3.0 mil thickness. The finish shall be baked in an oven for 15-20 minutes at a temperature ranging from 400°F. Warranty shall be a minimum of 15 years.

B. Acceptable manufacturers include the following:

1. Montage Commercial Grade (3-Rail) as manufactured by Ameristar Fence Products,
2. Imperial Fence, Style B (3 Rail) as manufactured by Master Halco,
3. Aberdeen fencing (3 Rail) as manufactured by Iron World Fencing.
4. Or equivalent.

2.3 SETTING MATERIALS

A. Concrete: Refer to Division 03, Section 03 30 00 - Cast in Place Concrete.

B. Post: Posts shall be embedded into concrete footings as shown on the plans.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Fence layout to be surveyed and staked by Contractor on finish grades.

3.2 FENCE INSTALLATION

A. Install the terminal posts for the gates per manufacturer's instructions if included.

B. Install fence at the location and heights per fence industry standards.

C. Set post uniformly at 8'-0" center to center unless otherwise indicated or required along curves or changes in slope.

D. Set posts in concrete having a diameter 4 times the diameter of the post.

E. Check each post for vertical and top alignment.

F. Attach panels to posts per manufacturer's instructions. All areas of paint or powdercoated surfaces scratched, dented or otherwise defected by installation shall be corrected by the Contractor at no expense to the Owner.

G. Install and secure specified post tops

3.4 CLEANING

A. Clean up debris and remove from the site.

END OF SECTION

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Section 32 31 20
GREEN TRELLIS FENCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related Sections include the following:
1. 03 30 00 - Cast-in-Place Concrete
2. 31 00 00 - Earthwork
3. 32 13 13 – Site Concrete
4. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
5. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
6. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

1.2 DESCRIPTION OF WORK

A. Furnish labor, materials and equipment to include Green Trellis Fencing for the referenced project.

1.3 SUBMITTALS

A. Changes in specification are only upon written approval by Owner.

B. Shop Drawings: Shall consist of dimensions, sizes, finishes and post foundations. Shop drawings shall be designed and detailed under the direct supervision of a licensed in house Professional Engineer. The Professional Engineer shall be present during the time the design and detailing is completed unless all details are included on the approval drawings bearing his/her seal.

C. Product Data: Manufacturer's certification indicating material compliance and installation.

D. Samples: Color selections for polyester powder coated finishes. If requested, samples of fence components delivered to Owner.

E. Sustainable Design Submittals:

1. Recycled content: Provide manufacturer's written certification of recycled content as defined in accordance with International Standard ISO 14021–1999, Environmental Labels and Declarations—Self-Declared

Environmental Claims (Type II Environmental Labeling). Indicate post-consumer and pre-consumer recycled content and provide documentation certifying products are from recycled sources. (LEED Credit MRc4).

2. Local/regional materials (LEED Credit MRc5):

   a. Indicate location of content of extraction, harvesting, and recovery; indicate the distance between extraction, harvesting, and recovery and the project site. Indicate percentage of product content from qualified locations.

   b. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.

3. Adhesives and Sealants: Include certification of data indicating Volatile Organic Compound (VOC) content of all field-applied adhesives and sealants and compliance with California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda. Submit MSDS highlighting VOC limits. (LEED Credit IEQc4.1).

PART 2 - PRODUCTS

2.1 ORNAMENTAL FENCE

A. Green Trellis Fence shall be Powder Coated Green Steel. Trellis grids shall be 3” max. spacing. Posts shall be a minimum of 4” sq. Post caps shall be flat style and constructed of aluminum or steel to form a weather-tight closure. All posts, caps, and fence panels shall be polyester coated individually after fabrication to thoroughly coat all surfaces for additional corrosion protection. All components shall enter a 5 stage in line cleaning process to prepare the galvanized surfaces for complete adhesion of the finish coat. Components shall be given a TGIC polyester resin powder coating applied by the electrostatic spray process to 3.0 mil thickness. The finish shall be baked in an oven for 15-20 minutes at a temperature ranging from 400°F. Warranty shall be a minimum of 15 years.

B. Acceptable manufacturers include the following:
   1. GREENscreen Freestanding Trellis Fence; Los Angeles, CA; phone: 800-450-3494, fax: 310-837-0523, www.greenscreen.com
   2. McNichols Eco-Mesh, Trellis System; P.O. Box 30300, Tampa, FL 336330-330; phone 800-237-3820, fax: 813-288-1828, sales@mcnichols.com
   3. VertiGreen 3D Trellis System, Tournesol Siteworks LLC; 42326 Albrae St., Freemont, CA 94538; phone: 800-542-2282, fax: 510-471-6243
   4. Or equivalent.

2.3 SETTING MATERIALS

A. Concrete: Refer to Division 03, Section 03 30 00 - Cast in Place Concrete.

B. Post: Posts shall be embedded into concrete footings as shown on the plans.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Fence layout to be surveyed and staked by Contractor on finish grades.

3.2 FENCE INSTALLATION

A. Install the terminal posts for the gates per manufacturer's instructions if included.

B. Set post uniformly at 6'-0" center to center unless otherwise indicated.

C. Set posts in concrete having a diameter 4 times the diameter of the post.

D. Check each post for vertical and top alignment.

E. Attach panels to posts per manufacturer's instructions. All areas of paint or powdercoated surfaces scratched, dented or otherwise defected by installation shall be corrected by the Contractor at no expense to the Owner.

F. Install and secure specified post tops

3.4 CLEANING

A. Clean up debris and remove from the site.

END OF SECTION

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Section 32 32 00

SEGMENTAL RETAINING WALL

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS, which are hereby, made a part of this Section of the Specifications.

B. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is NOT a proprietary specification and it should be noted that "Or approved equal" applies to all products denoted herein. It is understood that all manufactures will have minor variations in configuration, appearance, and product specifications and such minor variations shall not eliminate such manufacturers as an approved equal". It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that are able to supply similar products.

1.2 SCOPE

A. Work includes furnishing and installing segmental retaining wall (SRW) units to the lines and grades designated on the construction drawings or as directed by the Architect. Also included is furnishing and installing appurtenant and incidental materials required for construction of the retaining walls as shown on the construction drawings.

1.3 REFERENCES

A. The following standards and specifications listed below form a part of this specification where applicable.

1. Segmental Retaining Wall Units.
   a. ASTM C 140 - Sampling and Testing Concrete Masonry Units.
   b. ASTM C 94 – Ready-Mixed Concrete
   c. ASTM C 1372 – Segmental Retaining Wall Units
2. Geosynthetic Reinforcement.
   a. ASTM D 4595 -Tensile Properties of Geotextiles by the Wide-Width Strip Method.
   b. ASTM D 5262 -Test Method for Evaluating the Unconfined Creep Behavior of Geosynthetics.
   c. GRI:GG1 - Single Rib Geogrid Tensile Strength.
   d. GRI:GG5 - Geogrid Pullout.
3. Soils.
   a. ASTM D 698 - Moisture Density Relationship for Soils, Standard Method.
   b. ASTM D 422 - Gradation of Soils.
   c. ASTM 4318 - Atterberg Limits of Soil.

4. Drainage Pipe.
   a. ASTM 3034 - Specification for Polyvinyl Chloride (PVC) Plastic Pipe.
   b. ASTM D1248 - Specification for Corrugated Plastic Pipe.
5. Where specifications and reference documents conflict, the Architect shall make the final determination of applicable document.

1.4 SUBMITTALS

A. Material Submittals.
   1. The Contractor shall submit manufacturers' certifications two weeks prior to start of work stating that the intended SRW units and geosynthetic reinforcement meet the requirements of this specification.
   2. Submit representative block samples for selection of color and texture of exposed wall face(s) to the Architect. Desired exposed face and cap color samples are the color indicated on the plans

B. Design Submittal:
   1. The Contractor shall submit two sets of detailed design calculations and construction drawings for review and acceptance at least two weeks prior to the beginning of wall construction. All calculations and drawings shall be prepared and sealed by a Professional Engineer experienced in SRW wall design and licensed in the Commonwealth of Massachusetts.

1.5 DELIVERY, STORAGE AND HANDLING

A. Contractor shall check materials upon delivery to assure that specified type and grade of materials have been received and proper color and texture of SRW units have been received.

B. Contractor shall prevent excessive mud, wet concrete, epoxies, and like materials that may affix themselves by unintentional contact with SRW materials.

C. Contractor shall store and handle materials in accordance with manufacturer's recommendations.

D. Contractor shall protect materials from damage. Damaged materials shall not be incorporated into the retaining wall.

PART 2 - PRODUCTS

2.1 SEGMENTAL RETAINING WALL UNITS

A. Wall units shall be Re-Con, Redi-Rock, Strong Stone LLC or equivalent.

B. Wall units shall be made with Ready-Mixed concrete in accordance with ASTM C94, latest revision, and per the following chart:

Climate	Air Content	28 Day Compressive Strength, psi	Slump*
Negligible	1½%-4½%	4000	5” ±1 ½”
Moderate	3%-6%	4000	5” ±1 ½”
Severe	4½%-7½%	4000	5” ±1 ½”

*Higher slumps are allowed if achieved by use of appropriate admixtures. Notwithstanding anything stated above, all material used in the wall units must meet applicable ASTM and local requirements for exterior concrete.

C. Exterior block dimensions shall be uniform and consistent. Maximum dimensional deviations shall be 1% excluding the architectural surface. Maximum width (face to back) deviation including the architectural surface shall be 1.0 inch.

D. Exposed face shall be finished as specified. Other surfaces to be smooth form type. Dime-size bug holes on the block face may be patched and/or shake-on color stain can be used to blend into the remainder of the block face.

E. SRW units shall be machine formed, Portland Cement concrete blocks specifically designed for retaining wall applications.

F. Color of SRW units to be selected by the Architect. See Materials submittal requirements for further information in selection of applicable color(s).

G. SRW units shall be solid through the full depth of the unit.

H. For any corners shown on the construction plans, SRW units shall be capable of providing overlap of units on each successive course so that walls meeting at corner are interlocked and continuous. SRW units that require corners to be mitered shall not be allowed.

I. SRW units shall be capable of providing a split face, textured surface for all vertical surfaces that will be exposed after completion of wall, including any exposed sides and backs of units.

J. SRW units shall be sound and free of cracks or other defects that would interfere with the proper placing of the unit or significantly impair the strength or permanence of the structure. Cracking or excessive chipping is ground for rejection. Units showing cracks longer than 1/2" shall not be used within the wall. Units showing chips visible at a distance of 30 feet from the wall shall not be used within the wall.

K. Concrete used to manufacture SRW units shall have a minimum 28-day compressive strength of 3,000 psi and a maximum moisture absorption rate, by weight, of 8% as determined in accordance with ASTM C 140. Compressive strength test specimens shall conform to the saw-cut coupon provisions of Section 5.2.4 of ASTM C140 with the exception that the Coupon shall be taken from the least dimension of the unit of a size and shape representing the geometry of the unit as a whole.

L. SRW units' molded dimensions shall not differ more than + 1/8 inch from that specified, except height which shall be + 1/16 inch as measured in accordance with ASTM C140.

2.2 SEGMENTAL RETAINING WALL UNIT CONNECTION PINS

A. SRW units shall be interlocked with connection pins, of the material, size, and dimension as recommended and by the wall system manufacturer.

2.3 GEOSYNTHETIC REINFORCEMENT

A. Geosynthetic reinforcement shall consist of geogrid or geotextile manufactured as a soil reinforcement element. The manufacturers/suppliers of the geosynthetic reinforcement shall have demonstrated construction of similar size and types of segmental retaining walls on previous projects.

B. The type, strength, and placement location of the reinforcing geosynthetic shall be determined by the Wall Design Engineer, and shown on the design submittal.

2.4 LEVELING PAD

A. Material for leveling pad shall consist of compacted granular fill and shall be a minimum of 6 inches in depth. Lean concrete with a 28 day compressive strength of 200-300 psi and three inches thick maximum may also be used as a leveling pad material. The leveling pad should extend laterally at least a distance of 6 inches from the toe and heel of the lowermost SRW unit.

B. Free Draining Backfill material shall be washed stone and shall be placed to a minimum of 1’ width behind the back of the wall and shall extend vertically from the Leveling Pad to an elevation 6” below the top of wall.

2.5 DRAINAGE AGGREGATE

A. Drainage aggregate shall be angular, clean stone as specified by the Wall Design Engineer

2.6 DRAINAGE PIPE

A. The drainage collection pipe shall be a perforated or slotted PVC, or corrugated HDPE pipe. The drainage pipe shall be wrapped with a geotextile to function as a filter.

B. Drainage pipe shall be manufactured in accordance with ASTM D 3034 and/or ASTM D 1248.

2.7 REINFORCED (INFILL) SOIL

A. The reinforced soil material shall be free of debris. Reinforced material shall consist of the Granular Fill as indicated in Earthwork (Section 31 00 00) or material as required by the wall designer.

B. The maximum particle size of poorly-graded gravels (GP) (no fines) should not exceed 3/4 inch unless geosynthetic strength is reduced to account for additional installation damage from particles larger than this maximum.

C. The plasticity of the fine fraction shall be less than 20.

PART 3 – DESIGN PARAMETERS

3.1 SOIL

A. The following soil parameters shall be for preparation of final design documents by the Wall Design Engineer, unless otherwise directed by the Architect.

Strata	Unit Weight (pcf)	Internal Friction Angle (degrees)	Cohesion (c) (psf)
Reinforced Fill	125	30	0
Retained Soil	125	30	0
Foundation Soil	125	30	0

B. The design of the permanent wall system shall include an allowance of at least a two foot (2 ft) depth uniform vertical soil surcharge loading where walls retain roadway fills. This provision is applicable when the distance from the face of wall to the edge of road is less than the design wall height.

C. The wall system may also be designed to account for reasonable temporary surcharge conditions during construction, such as those due to stockpiling of soil or other construction materials.

D. The construction drawings shall indicate the design limitations of the wall system.

E. Should the actual soil conditions observed during construction differ from those assumed for the design, the Wall Design Engineer shall review the design.

3.2 DESIGN

A. The design provided by the Contractor and prepared by their Wall Design Engineer shall consider the internal and local stability of the reinforced soil mass and shall be in accordance with acceptable engineering practice and these specifications.

B. The Wall Design Engineer shall confirm that the global stability limit states of sliding, overturning, and the allowable bearing pressure on foundation soil(s) have not been exceeded for the design conditions. Minimum factors of safety for design of permanent conditions are as follows:

Overturning	2.0
Sliding	1.5
Bearing Pressure	2.0

C. Where other site development features are to be installed adjacent to walls by the Contractor, the design of the wall system shall be developed to accommodate the potential for geotextile penetrations, such as fence and/or guardrail posts.

D. Note that as located the backfill is sloped to a parking area.

3.3 LEVELING PAD PLACEMENT

A. Leveling Pad shall be placed as shown on the construction drawings.

B. Leveling Pad shall be placed on undisturbed native soils or suitable replacements fills.

C. Leveling Pad shall be compacted to 95% of standard proctor or 90% of modified proctor to ensure a level, hard surface on which to place the first course blocks. Pad shall be constructed to the proper elevation to ensure the final elevation shown on the plans.

D. Leveling Pad shall have a 6 inch minimum depth for walls under 8 feet in height and a 12 inch minimum depth for walls over 8 feet. Pad dimensions shall extend beyond the blocks in all directions to a distance at least equal to the depth of the pad or as designed by Engineer.

E. For steps and pavers, a minimum of 1” - 1 ½” of free draining sand shall be screeded smooth to act as a placement bed for the steps or pavers.

PART 4 - CONSTRUCTION

4.1 INSPECTION

A. The Architect is responsible for verifying that the Contractor meets all the requirements of the specification. This includes all submittals for materials and design, qualifications, and proper installation of wall system.

1. Contractor's field construction supervisor shall have demonstrated experience and be qualified to direct all work at the site.

4.2 EXCAVATION

A. Contractor shall excavate to the lines and grades shown on the project grading plans. Contractor shall take precautions to minimize over-excavation. Over-excavation shall be filled with compacted infill material, or as directed by the Architect, at the Contractor's expense.

B. Contractor shall verify location of existing structures and utilities prior to excavation. Contractor shall ensure all surrounding structures are protected from the effects of wall excavation. Excavation and/or adjacent structure or utility support, if required, is the design and installation responsibility of the Contractor.

4.3 FOUNDATION PREPARATION

A. Following the excavation, the foundation soil shall be examined by the Architect to assure actual foundation soil strength meets or exceeds the assumed design bearing strength. Soils not meeting the required strength shall be removed and replaced with infill soils, as directed by the Architect.

B. Foundation soil shall be proof rolled or otherwise compacted to 95% modified Proctor density (ASTM D 1557) and inspected by the Architect prior to placement of leveling pad materials.

4.4 LEVELING PAD CONSTRUCTION

A. Soil leveling pad material shall be compacted to provide a firm, level, bearing surface on which to place the first course of units. Well-graded sand can be used to smooth the top 1/2 to 1/4 inch of the leveling pad. Compaction will be with mechanical plate compactors to achieve 95% of maximum modified Proctor (ASTM D 1557) density.

4.5 SRW UNIT INSTALLATION

A. All SRW units shall be installed at the proper elevation and orientation as shown on the wall profiles and details on the construction plans or as directed by the Architect. The SRW units shall be installed in general accordance with the manufacturer's recommendations. The specifications and drawings shall govern in any conflict between the two requirements.

B. First course of SRW units shall be placed on the leveling pad. The units shall be leveled side-to-side, front-to-rear and with adjacent units, and aligned to ensure intimate contact with the leveling pad. The first course is the most important to ensure accurate and acceptable results. No gaps shall be left between the front of adjacent units. Alignment may be done by means of a string line or offset from base line to the back of the units.

C. Clean all excess debris from top of units and install next course.

D. Install next course of wall units on top of base row. Position blocks to be offset from seams of blocks below. Blocks shall be placed fully forward so knob and groove are engaged. Check each block for proper alignment and level. Backfill to 12 inch width behind block with Free Draining Backfill. Spread backfill in uniform lifts not exceeding 9 inches. Employ methods using lightweight compaction equipment that will not disrupt the stability or batter of the wall. Hand-operated plate compaction equipment shall be used around the block and within 3 feet of the wall to achieve consolidation. Compact backfill to 95% of standard proctor (ASTM D 698, AASHTO T-99) density within 2% of its optimum moisture content.

E. Layout of curves and corners shall be installed in accordance with the plan details or in general accordance with SRW manufacturer's installation guidelines. Walls meeting at corners shall be interlocked by overlapping successive courses.

F. Install each subsequent course in like manner. Repeat procedure to the extent of wall height.The wall face cant (batter) shall not differ more than $\pm$ 2 degrees from that specified.

G. Allowable construction tolerance at the wall face is 2 degrees vertically and 1 inch in 10 feet horizontally.

H. All walls shall be installed in accordance with local building codes and requirements.

4.6 GEOSYNTHETIC REINFORCEMENT PLACEMENT

A. All geosynthetic reinforcement shall be installed at the proper elevation and

orientation as shown on the wall profiles and details on the final construction plans or as directed by the Architect

B. At the elevations shown on the final plans, the geosynthetic reinforcement shall be laid horizontally on compacted infill and on top of the concrete SRW units. Embedment of the geosynthetic in the SRW units shall be consistent with SRW manufacturer's recommendations. Correct orientation of the geosynthetic reinforcement shall be verified by the Contractor to be in accordance with the geosynthetic manufacturer's recommendations. The highest strength direction of the geosynthetic must be perpendicular to the wall face.

C. Geosynthetic reinforcement layers shall be one continuous piece for their entire embedment length. Overlap of the geosynthetic in the design strength direction (perpendicular to the wall face) shall not be permitted.

D. Tracked construction equipment shall not be operated directly on the geosynthetic reinforcement. A minimum of 6 inches of backfill is required prior to operation of tracked vehicles over the geosynthetic. Turning should be kept to a minimum. Rubber-tired equipment may pass over the geosynthetic reinforcement at slow speeds (less than 5 mph).

E. The geosynthetic reinforcement shall be in tension and free of wrinkles prior to placement of soil fill. The nominal tension shall be applied to the reinforcement and secured in place with staples, stakes or by hand tensioning until reinforcement is covered by six inches of fill.

4.7 DRAINAGE MATERIALS

A. Drainage aggregate shall be installed to the line, grades, and Sections shown on the final plans. Drainage fill shall be placed to the minimum thickness shown on the construction plans between and behind units.

B. Drainage collection pipes shall be installed to maintain gravity flow of water outside the reinforced soil zone. Unless shown otherwise on the plans, drainage collection piping shall daylight into a storm sewer manhole or along a slope at an elevation lower than the lowest point of the pipe within the aggregate drain.

4.8 BACKFILL PLACEMENT

A. The reinforced backfill shall be placed as shown in the construction plans in the maximum compacted lift thickness of 12 inches and shall be compacted to a minimum of 95% of modified Proctor density (ASTM D 1557) at a moisture content within 2% of optimum. The backfill shall be placed and spread in such a manner as to eliminate wrinkles or movement of the geosynthetic reinforcement and the SRW units.

B. Backfill placement shall commence at the back of the wall and progress towards the retained material.

C. Only hand-operated compaction equipment shall be allowed within 3 feet of the front of the wall face. Compaction within the 3 feet behind the wall face shall be achieved by at least three (4) passes of a lightweight mechanical tamper, plate, or roller.

D. At the end of each day's operation, the Contractor shall slope the last level of backfill away from the wall facing to direct water runoff away from the wall face.

E. At completion of wall construction, backfill shall be placed level with final top of wall elevation. If final grading, paving, landscaping, and/or storm drainage installation adjacent to the wall is not placed immediately after wall completion, temporary surface drainage shall be provided to ensure water runoff is not directed at the wall nor allowed to collect or pond behind the wall until final construction adjacent to the wall is completed.

4.9 SRW CAPS

A. SRW caps shall be properly aligned and attached to underlying units with a suitably flexible, high-strength concrete adhesive. Rigid adhesives or mortar will not be accepted.

B. Caps shall overhang the top course of units by 3/4 to 1 inch. Slight variation in overhang is allowed to correct alignment at the top of the wall.

4.10 CONSTRUCTION ADJACENT TO COMPLETED WALL

A. The Contractor is responsible for ensuring that construction adjacent to the wall does not disturb the wall or place temporary construction loads on the wall that exceed design loads, including loads such as water pressure, temporary grades, or equipment loading. Heavy paving or grading equipment shall be kept a minimum of three feet behind the back of the wall face. Contractor to ensure water runoff is directed away from the wall structure until final grading and surface drainage collection systems are completed.

End of Section

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Section 32 32 10
BOULDER PLACEMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B Related Sections: The following sections contain requirements that relate to this section.
1. Division 31 Section "Earthwork" for subgrade preparation, grading and subbase occurs.

1.2 DESCRIPTION OF WORK

A. Provide all materials, equipment and labor necessary to complete the work as indicated on the drawings or as specified herein.

B. The principal work of this section includes, but may not be limited to, the following:
1. Layout and Excavation of Areas
2. Placement of Boulders in Landscape
3. Placement of Boulders in Pavement

1.3 QUALITY ASSURANCE

A. The Landscape Architect reserves the right to inspect all materials and placement of materials for compliance with specifications, and to reject unsatisfactory or defective materials and/or layout at any time during progress of work.

B. Do not make substitutions without written approval. If specified landscape material is not available, obtain approval for substitution from the Landscape Architect.

1.4 SUBMITTALS

A. A sample Boulder and Decorative Block Boulder shall be selected by the Landscape Architect through the Contractor to show the texture, finish, and anticipated range of color and size to be supplied and shall be stored on site.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Protect all products from weather or other damaging or deteriorating conditions.

B. Product will be stored in location specified by General Contractor.

PART 2 - PRODUCTS

2.1 BOULDER IN LANDSCAPE

A. Boulders sizes per plans and details.

B. Boulder colors will be grey and tan in color. Variations in color shall be approved by the Landscape Architect.

C. Boulders will be more rounded in form. See figure 2.1 and 2.2 for sample boulder photo.

Figures 2.1 and 2.2

D. Texture and finish shall be within the range of samples approved by the Landscape Architect.

E. Boulders from site can be re-used upon approval from Landscape Architect.

2.2 BOULDERS IN PAVEMENT

A. Boulder sizes per plans and details with the following additions:

1. Boulders shall have dimensions meeting those detailed in the plans.

B. Boulders will be grey and tan in color. Variations in color shall be approved by the Landscape Architect.

C. Boulders shall be set prior to site concrete. See figure 2.3 and 2.4 for sample of Boulders in Pavement photo.

Figure 2.3 and 2.4

D. Texture and finish shall be within the range of samples approved by the Landscape Architect.

E. Boulders from site can be re-used upon approval from Landscape Architect.

PART 3 - EXECUTION

3.1 PLACEMENT OF BOULDER

A. Boulder shall be placed on compacted sand gravel fill per the drawings.

B. Boulder will be placed as indicated on the plans.

C. Boulder shall be buried in accordance with the drawings and details.

END OF SECTION

Section 32 50 00

STORMWATER POLLUTION PREVENTION PLAN

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. This section is only a portion of the Contract Documents. All of the Contract Documents, including Division 1 General Requirements, apply to this section.

1.2 DESCRIPTION OF WORK

A. This Section specifies requirements for implementation of the Storm Water Pollution Prevention Plan (SWPPP), which shall be provided by the Contractor prior to construction.

B. The storm water pollution prevention measures contained in the SWPPP are the minimum required by US Environmental Protection Agency (EPA). The Contractor shall provide additional measures to prevent pollution from storm water discharges in compliance with the NPDES and all other local, state and federal requirements. The Contractor shall be responsible for complying with the provisions of the SWPPP.

C. The Contractor shall NOT begin construction without submitting evidence that a "National Pollution Discharge Elimination System" (NPDES) Notice of Intent governing the discharge of storm water from the construction site for the entire construction period has been filed at least two weeks prior to construction.

D. The Contractor shall conduct the storm water management practices in accordance with local regulations and governing authorities, the Federal NPDES permit requirements and for any enforcement action taken or imposed by Federal or State agencies. The cost of any fines, construction delays and remedial actions resulting from the Contractor's failure to comply with all provisions of local regulations and Federal NPDES permit requirements shall be paid for by the Contractor at no additional cost to the Owner.

E. As a requirement of the EPA's NPDES permitting program, the Owner, each Contractor and Subcontractor shall execute a Contractor's Certification form, a copy of which is included in the SWPPP.

F. Dust control shall be the responsibility of the Contractor and dust control operations shall meet the requirements of the Commonwealth of Massachusetts Department of Environmental Protection 310 CMR 7.09: Air Pollution Control Regulations.

G. Water shall be used to control dust.

1.3 DESCRIPTION OF WORK

A. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 31 25 00 – EROSION CONTROL.

1.4 REFERENCES

A. Guidance Manual—"Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices" (EPA 832-R-005).

B. Summary of Guidance Manual—"Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices" (EPA).

C. National Pollution Discharge Elimination System General Permit for Discharges from Construction Activities, February 16, 2012, EPA.

D. Massachusetts Stormwater Management Standards Handbook, February 2008.

E. Massachusetts “Erosion and Sedimentation Control Guidelines for Urban and Suburban Areas, A Guide for Planners, Designers, and Municipal Officials” prepared by Department of Environmental Protection (DEP), Reprinted May 2003.

F. Commonwealth of Massachusetts, Department of Public Works, Standard Specifications for Highways and Bridges, latest edition, herein referred to as the “Standard Specifications” and related articles.

1.5 SUBMITTALS

A. The Stormwater Pollution Prevention Plan.

B. Contractor's Certification for Contractor and each Subcontractor.

C. Copies of Contractor's inspection reports.

D. Names, addresses, and telephone numbers of Contractors and Subcontractors responsible personnel who can be contacted under emergency conditions.

E. A construction schedule which indicates specific activities related to the SWPPP.

F. A supplemental Plan indicating location of laydown and staging areas, and their incorporation into the SWPPP.

1.6 INSPECTIONS

A. The Contractor will conduct the inspections per the SWPPP. The Contractor will implement any actions to maintain full compliance with the SWPPP.

B. A maintenance inspection report shall be prepared after each inspection, by the Contractor. The Contractor shall identify one individual who will be responsible keeping the site in full compliance with the SWPPP and maintaining an up-to-date copy of the SWPPP onsite.

PART 2 - PRODUCTS

2.1 WATER FOR DUST CONTROL:

A. Water used shall be clean, non-polluted water obtained from sources approved by the Owner and/or Engineer.

PART 3 - EXECUTION

3.1 EROSION CONTROL DEVICES:

A. Erosion Control Devices shall be constructed as shown on the SWPPP and as specified in the plans and specifications.

3.2 STORM WATER POLLUTION PREVENTION PRINCIPLES

A. The following general principles shall be followed by the Contractor during the construction phase:

1. Protect and maintain existing vegetation wherever possible.
2. Minimize the area of disturbance.

3. To the extent possible, route unpolluted flows around disturbed areas.
4. Install mitigation devices as early as possible.
5. Minimize the time disturbed areas are left unstabilized.
6. Maintain siltation control devices in proper condition.

3.3 STORM WATER POLLUTION PREVENTION PLAN

A. The Contract drawings and specifications identify a portion of the required facilities and temporary erosion control devices. The Contractor shall prepare a SWPPP in accordance with NPDES requirements which identifies the location of construction facilities and proposes additional erosion control measures as necessary to minimize pollution. The SWPPP shall include provisions for but not be limited to the following:

1. Construction Trailers
2. Laydown Areas
3. Equipment Storage Areas
4. Stockpile Areas

B. Reproducibles of one or more of the Contract Drawings will be provided to the Contractor to serve as a base for the Contractor's SWPPP.

3.4 APPLICATION – WATER:

A. The application of water shall be under the control of the Contractor at all times. It shall be applied only at the locations, and at such times, and in the amount as may be directed by the Owner. Quantities of water wasted or applied without authorization will not be paid for.

B. The Contractor shall have available and maintain in an operable condition at all times, sufficient equipment for the purpose of applying water for dust control.

C. Watering equipment shall consist of pipelines, tanks, tank trucks, distributors, pumps, meters, hose or other devices, approved by the Owner, which are capable of applying a uniform spread of water over the surface. A suitable device for a positive shut-off and for regulating the flow of water shall be located so as to permit positive operator control.

End of Section

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Section 32 84 00
IRRIGATION SYSTEM

PART 1 - GENERAL

1.01 CONDITIONS

A. Refer to Division 01 – General Requirements for general contract terms and conditions.

B. Review all relevant Construction Documents before submitting bid including referenced Drawings and Specifications, as well as overall Contract Construction Documents.

C. Review existing conditions on site before submitting bid. Unauthorized requests for extra time or compensation due to actual conditions being inconsistent with those assumed shall not be honored, except those conditions described in General Contract terms and conditions.

D. Qualifications submissions required with bid:
1. Irrigation system installers shall have minimum four (4) years of experience with Work and Products described in Construction Documents, including:
   a. Two-Wire Controller and Valve Installation
   b. Gasket-Joint PVC Pipe with Ductile Iron Fittings
   c. Weather-Based Controllers
2. Irrigation system installers shall submit a minimum three (3) references verifying similar Work described in Construction Documents, including:
   a. Contact Person Name, Role, and Project
   b. Telephone Number and/or E-Mail Address
3. Irrigation system installer shall be approved by Owner's Representative to commence Work based on qualifications and competitive bid price.

1.02 IRRIGATION SYSTEM WORK

A. Provide all materials, labor, installation equipment, and technical service to complete work for automatic landscape irrigation system for athletic fields as described in Construction Documents.

B. Construction Documents
1. Drawings
2. Specifications
3. Contractor initiated Requests for Information (RFI)
   a. Apparent discrepancies or questions of intent shall be immediately directed in writing to Owner's Representative for final, conclusive and binding decision.

C. Contract Work Summary
1. Irrigation Controller and Sprinkler Work
   a. Provide new irrigation equipment including, but not limited to rotor sprinklers, valves, lateral and mainline pipe for athletic fields as shown on Drawings.
   b. Provide all trenching, bedding material, backfilling, and compaction for all in-ground irrigation system components.
   c. Install new irrigation controller within outdoor pedestal on concrete pad where shown and by installation details as shown on Drawings. Controller are two-wire compatible.
2. Testing, Adjustment, and Final Documentation

a. Test and adjust irrigation mainline and sprinkler systems as required for coverage and undue vibrations.
b. Provide Record Drawing with standards outlined in Specifications (see Section 3.02).
c. Provide Operations & Maintenance Manual with standards outlined in Specifications (see section 3.03).
d. Provide training with Owner's Representative and designated irrigation maintenance staff for two (2) hours prior to system acceptance.

3. Guarantee
   a. Guarantee entire irrigation system, parts and labor, for one (1) year from official written date of acceptance by Owner's Representative. Written warranty showing date of completion and period of warranty shall be provided at completion.
   b. System malfunctions occurring during the guarantee period due to defective materials, poor workmanship, or improper adjustment shall be corrected to satisfaction of Owner's Representative at no additional expense to the Owner.
   c. First-year spring start-up and winterization shall be included in system guarantee.
   d. Obtain standard written manufacturer warranty of all products and materials provided where such warranties are offered in published product data. Include these warranties in Operations & Maintenance Manual (see section 3.03). These warranties shall be in addition to, and not in lieu of, other binding warranties or guarantees.

1.03 UTILITIES PROVIDED

A. Water Source by Priority
   1. Well Water controlled by VFD at constant pressure of 95 psi at 300 gpm maximum

B. Electrical Power Sources
   1. Automatic Irrigation Controller
      a. Project Electrical Contractor shall provide dedicated building electrical power circuits at 120-Volt, 1-Phase, 60-Hz, 20-Amp for new controller (refer to Division 26 – Electrical).

1.04 TRADE COORDINATION

A. Coordinate with other project trades and refer to overall project Construction Documents drawings and specifications by section including, but not limited to:
   1. Division 01 – General Requirements
   2. Division 02 – Existing Conditions
   3. Division 22 – Plumbing
   4. Division 26 – Electrical
   5. Division 27 – Communications
   6. Division 31 – Earthwork
   7. Division 32 – Exterior Improvements
   8. Division 33 – Utilities

1.05 APPLICABLE STANDARDS AND CODES

A. Work shall comply with applicable requirements and accepted practice as established in recognized standards and codes published by the following bodies (capitalized abbreviations used through Specifications):
   1. American Society for Testing and Materials (ASTM)
   2. National Standard Plumbing Code (NSPC)
   3. National Electric Code (NEC)
   4. National Sanitary Foundation (NSF)

5. Underwriters Laboratories, Inc. (UL)
6. Occupational Safety and Health Administration (OSHA)

B. All local standards and codes that are more stringent than standards and codes referenced above shall take precedent on project (see section 3.01).

1.06 SUBMITTALS

A. Provide electronic copies of product sheets and catalog cuts for all product specified to Owner's Representative for approval as per Division 01.

B. Work shall not commence until all products specified are submitted and approved by Owner’s Representative. Work shall commence only after written notification from Owner’s Representative.

C. Product submittals shall be concise (no extraneous pages or sections) and clearly marked to show submitted product model, type, size, etc. Submittals with extraneous pages and not marked clearly are subject to rejection by Owner’s Representative.

D. Substitute Product Submittals
1. Provide specified product submittals "or approved equal", in which case, submit substitution product submittal to Owner’s Representative for approval.
2. Certain manufacturer names and model numbers are used throughout Specifications, denoting minimum standard.
3. Alternate products are acceptable when products of equal or better quality and performance are submitted and approved in the procedure outlined in Section 1.06.
4. Substitute product submittals constitute representation that:
   a. Substitute products have been thoroughly investigated and have been determined to be equal or superior in all respects to that specified
   b. Substitute products shall provide same warranties as specified products
   c. Substitute products are compatible with interfacing items
   d. Responsibility has transferred to system installer to coordinate substitute product and to make all subsequent changes required in other elements of work

E. All product installed shall be new, without defects, and of quality and performance as specified and meeting requirements of system.

F. Products to be submitted for approval shall include, but not be limited to:
1. Automatic Irrigation Controller
2. External Sensors for Controller
3. Wire and Connectors
4. Pipe and Fittings
5. Conduit and Fittings
6. Manual, Self-Regulating, and Electric Valves
7. Sprinklers and Nozzles
8. Valve Boxes
9. Grounding Equipment
10. Miscellaneous Materials

1.07 ON-SITE MATERIALS MANAGEMENT

A. Store and handle all products and materials in compliance with manufacturer instructions and recommendations.

B. Protect from all possible damage while on-site from other trades, while staged for installation, and during installation.

C. Minimize on-site storage where possible. Coordinate with site supervisor for storage options.

D. All material overages at installation completion shall be removed from site.

PART 2 - PRODUCTS

2.01 AUTOMATIC IRRIGATION CONTROLLER

A. Controller
1. Size: 12 inches tall x 15 inches wide x 6 inches deep
2. Construction: Electronic with 120-Volt Input and 24-28 Volt Output, Stainless Steel Pedestal Enclosure (VIT Strongbox, Model SB-16SS-OPT-HUN-ACC)
3. Standards: UL-Listed
4. Features: Manual and Automatic Control, Water Budgeting, Cycle-Soak, Sensor Input Terminals, Internal Transformer, Flow Monitoring Capability, Lightning Protection, Remote Control, Two-Wire System with Conventional Wire Retrofit Capability
5. Manufacturers: Hunter, Model ACC99 or Approved Equal

B. External Devices (Matching Controller Manufacturer)

1. Weather Sensor: Hunter Solar Sync (Sunlight/ET, Rain, and Temperature)
2. Decoders: Hunter ICD-100 and ICD-200, with grounding as required
3. Flow Sensor: Hunter HFS-308
4. Remote Control: Hunter ROAM, ROAM-XL

C. Outdoor Grounding of Controller

1. Size: Wire = 6AWG Bare, Rod = 5/8-Inch Diameter x 10-Foot Long; Plate = 4-Inch x 96-Inch x 1/16-Inch Thick
2. Construction: Wire = Copper; Rod = Copper; Plate = Copper with Loresco PowerSet Ground Enhancement Material Above and Below
3. Ratings: UL-Listed
4. Features: Cadweld Connectors from Wire to Rod, Plate Manufacturer provided Plate Connections, PVC or ADS Drain Pipe and Grate Cover over Rod and Plate with Metal Detection

2.02 WIRE

A. Two-Wire to Decoders(24-28 VAC)
1. Size: 14AWG Minimum (Common 12AWG Minimum)
2. Construction: Dual Strand Solid Copper Conductors with PVC Insulation and Poly Jacket
3. Ratings: UL-Listed, NEC (Class II Circuit), Direct Burial UF/TWU, up to 600-Volt Potential
4. Standards: ASTM B-3, B-8
6. Markings: Manufacturer, Rating, Size and Type
7. Manufacturers: Coleman Cable #51452; Paige P7072D, P7296D, P7350D, and P7354D; Regency 14/2 and 12/2 Maxi Cable; Hunter Decoder Jacketed; Service Wire DEC12/2BE and DEC14/2BE

B. Conventional Wire and Decoders to Electric Zone Valves

1. Size: 14AWG Minimum (Common 12AWG Minimum)
2. Construction: Single Strand Solid Copper Conductor with PVC Insulation
3. Ratings: UL-Listed, NEC (Class II Circuit), Direct Burial UF/TWU, up to 600-Volt Potential
4. Standards: ASTM B-3, B-8
5. Colors: Sprinkler = Red, Spares = Blue, Common = White
6. Markings: Manufacturer, Rating, Size and Type
7. Manufacturers: Paige Electric, Model P7001D; Service Wire Company, Model UF14, UF12; Regency Wire & Cable, Model 14AWG, 12AWG; or Approved Equal

C. Wire Splices
1. Type: Direct Bury Wire Splice Kit (All Components Intact)
2. Construction: Lockable Plastic Tube, Pre-Filled with Insulation Gel
3. Ratings: UL-Listed, NEC, Direct Burial and Submersion, up to 600-Volt Potential
4. Manufacturers: 3M, Model DBY-6; Rain Bird, Model DB Series; or Approved Equal

D. Wire Conduit (Below Grade)
1. Size: 1-inch Minimum
2. Construction: Valve Wire = Polyvinyl Chloride (PVC), Solvent Weld Below-Grade; Galvanized Steel for
3. Ratings: Schedule 40
4. Fittings: Long Sweep Elbows
5. Manufacturers: Cresline; Certainteed; JM Eagle; or Approved Equal

2.03 PIPE AND FITTINGS

A. Small Irrigation Mainline and Laterals
1. Size: 2½-inch Maximum
2. Construction: Polyvinyl Chloride (PVC), Solvent Weld
3. Ratings: Class 200, Type 1120, SDR 21
4. Standards: ASTM D-2241
5. Colors: Reclaimed Water = Purple; All Other Water = White
6. Markings: Manufacturer, Nominal Size, Class or Schedule, Pressure, Extrusion Date, Pipe Insertion Mark, Reclaimed Water = “Reclaimed Water – Do Not Drink”
7. Fittings: For Valves Schedule 80 PVC Toe Nipples (Threaded); All Other Schedule 40 PVC
8. Manufacturers: Cresline; Certainteed; JM Eagle; or Equal

B. Large Irrigation Mainline and Laterals
1. Size: 3-inch Minimum (6-inch Maximum)
2. Construction: Polyvinyl Chloride (PVC), Gasket Joint
3. Ratings: Class 200, Type 1120, SDR 21
4. Standards: ASTM D-2241
5. Colors: Reclaimed Water = Purple; All Other Water = White
6. Markings: Manufacturer, Nominal Size, Class or Schedule, Pressure, Extrusion Date, Pipe Insertion Mark, Reclaimed Water = “Reclaimed Water – Do Not Drink”
7. Fittings: Ductile Iron Push-On Joints (Harco, or Approved Equal) with Thrust Blocks at each change in direction or tee
8. Manufacturers: Cresline; Certainteed; JM Eagle; or Equal

2.04 ELECTRIC ZONE VALVES

A. Sprinkler Zones
1. Size: 1-Inch, 1½-Inch, 2-Inch
2. Construction: Plastic Diaphragm with Reinforced Nylon or Fiberglass Body

3. Ratings: 200 psi rating
4. Features: Manual Bleed Screw, Flow Control, Pressure Regulations, and Filter
5. Manufacturers: Hunter, Model ICV with Filter Sentry; or Approved Equal

B. Master Valve
1. Size: 3-Inch
2. Construction: Brass Globe Valve
3. Ratings: 220 psi rating
4. Features: Manual Bleed Screw, Flow Control, Pressure Regulations, and Filter
5. Manufacturers: Hunter, Model IBV with Filter Sentry; or Approved Equal

2.05 ISOLATION VALVES

A. Small Mainline
1. Size: 2-Inches and Smaller
2. Construction: Gate Valve, Bronze (Manufactured in the United States)
3. Ratings: 200 psi
4. Features: Steel Cross Handle, Non-Rising Stem
5. Manufacturers: Nibco, Model T-113K, Apollo, Model 102T-K; or Approved Equal

B. Large Mainline with Gasket-Joint Pipe
1. Size: 3-Inches and Larger
2. Construction: Ductile Iron Gate Valve
3. Ratings: 200 psi
4. Features: 2-Inch Operating Nut, Non-Rising Stem
5. Manufacturers: Nibco, Model P-619-RW; or Approved Equal

2.06 QUICK COUPLING VAVLES

A. Mainline Valves
1. Size: 1-Inch, Normally Closed
2. Construction: Brass, Spring-Loaded Valve Seat, Key Engaged, Brass Swing Joint Assembly off Ductile Iron Service Tee
3. Ratings: 125 psi
4. Features: ACME Key with 1-Inch Male ACME and ¾ Female ACME Top, Vinyl Cover, Add 1-Inch Pressure Regulating Valve on Riser from Service Tee
6. Manufacturers: Hunter, Model HQ-44RC-AW; or Approved Equal; Pressure Regulating Valve shall be Rain Bird; Model PSI-M40X-100, or Approved Equal

2.07 VALVE BOXES

A. General
1. Construction: Resin
2. Ratings: Tensile Strength = 3,000 – 5,000 psi
3. Color: Green or Black (per Owner's Representative)
4. Features: Lockable, Bolt-Down Covers
5. Manufacturers: Carson, Model Specification Grade, NDS Pro; Rain Bird VB, or Approved Equal

B. Wire Splices
1. Size: 6-Inch Round.

C. Single 1-Inch & 1½-inch Electric Zone Valves, Isolation Valves, Quick Coupling Valves
1. Size: 10-Inch Round

D. Single 2-Inch, Double Electric Zone Valves
   1. Size: Standard 12-Inch Valve Box

2.08 ROTOR SPRINKLERS

A. 28-36 foot Radius (Baseball Infield and Foul Territory)
   1. Size: 6-Inch Pop-Up Height with ¾-inch FPT inlet
   2. Ratings: Approved Effective Radius shall be 80% of Manufacturer Radius by Nozzle, 55 psi minimum.
   3. Construction: Gear-Driven, Removable Nozzle, Internal Check Valve, Stainless Steel Retraction Spring, Rubber Cover, Stainless Steel Riser
   4. Feature: Adjustable Part and Full Circle
   5. Manufacturers: Hunter, I-20-06-SS with Design Nozzles, or Approved Equal.

B. 50 foot Radius and Above (Playing Surfaces)
   1. Size: 6-Inch Pop-Up Height with ¾-inch FPT inlet
   2. Ratings: Approved Effective Radius shall be 80% of Manufacturer Radius by Nozzle, 70 psi minimum.
   3. Construction: Gear-Driven, Removable Nozzle, Internal Check Valve, Stainless Steel Retraction Spring, Rubber Cover, Stainless Steel Riser
   4. Feature: Adjustable Part and Full Circle
   5. Manufacturers: Hunter, I-40-06-SS with Design Nozzles Shown on Drawings, or Approved Equal.

2.09 EARTH MATERIALS

A. Stone (in Valve Boxes)
   1. Size: ¾-Inch Minimum Crushed Stone

B. Sand (Trench Backfill)
   1. Rating: Minimum 80% passing through #4 Sieve, Maximum 5% Passing #200 Sieve

C. Concrete (Thrust Blocks)
   1. Ratings: 3,000 psi Compressive Strength at 28 Days
   2. Standards: ASTM C-33, ASTM C-94, ASTM C-150

2.10 SPARE IRRIGATION PARTS

A. Wrenches, Keys, and Tools for Servicing and Adjusting Sprinkler Heads (2)

B. Quick Coupler Valve Keys (1)

C. Gate Valve (1)

D. Electric Zone Valve (1)

E. Sprinkler Heads (3 of Each)

F. Nozzles (3 of Each)

PART 3 - EXECUTION

3.01 GENERAL

A. Verify dimensions and grades at job site prior to work.

B. Suspend installation of irrigation system when obstructions or grade discrepancies exist or if conflicts in construction documents and actual conditions exist. Bring to immediate attention of Owner's Representative for resolution.

C. Make field measurements as necessary noting relationship of irrigation to other trades. Coordinate with other trades (landscaping and other site work trades). Project shall be laid out essentially as indicated on Drawings, making minor adjustments for variations in planting arrangements or field conditions. Major changes shall be reviewed with Owner's Representative prior to proceeding.

D. Sprinkler lines on Drawings are diagrammatic only. Location of sprinkler equipment is contingent upon and subject to integration with all other underground utilities, tree roots, and hardscape design elements. Employ all data contained in Contract Documents and verify this information at construction site to confirm manner by which it relates to installation.

E. Competent superintendents and assistants shall be on site at all times. Superintendent changes shall not be allowed without consent of Owner's Representative. Superintendent shall represent firm as directions given shall be binding.

F. At all times, protect landscaping, paving, structures, walls, footings, etc. from damage. Any inadvertent damage to work of another trade shall be reported at once. Replace, or repair to satisfaction of Owner, all existing paving disturbed during course of work with same type, strength, texture, and finish as original paving.

G. Ordinances, Permits, and Permit Fees
1. Comply with all ordinances and regulations of authorities having jurisdiction.
2. Obtain and pay for any and all permits, tests and certifications required.
3. Furnish copies of Permits, Certifications and Approval Notices to Owner's Representative prior to requesting payment.
4. Bid shall include any charges by local water department, utility company, or other imposed and necessary fees.

3.02 ON-SITE INSTALLATION COORDINATION

A. Coordinate work closely with Owner's Representative to expeditiously install system.

B. Written (electronic form is acceptable) notifications shall be given to Owner's Representative prior to work commencement, regularly for progress report, proposed changes to proposed system design, and upon system installation completion.

C. Coordinate with and inform all hired subcontractors of site parameters and design intentions.

D. Adhere to all security and check-in procedures with on-site project supervisor.

E. Assume responsibility and compensate Owner for all damage to other work caused by irrigation system work, workers, or subcontractors. Repairing of such damage shall be done by personnel as directed by Owner's Representative.

F. Where applicable, notify all municipal departments and utilities as to time and location of any work affecting those entities. Cooperate and coordinate in protecting or repairing such infrastructure.

G. Provide and install temporary support, adequate protection, and maintenance of all structures, drains, sewers, and other obstructions encountered. Where grade or alignment is obstructed, obstruction shall be permanently supported, relocated, removed or reconstructed as directed by Owner's Representative.

H. All questions of design intent, proposed design changes, field notifications, and product substitution after installation commences shall be in writing to Owner's Representative as a Request for Information (RFI).

3.03 PIPE INSTALLATION

A. With trencher, excavate straight and true trench 2 inches below pipe invert.

B. Trench Base
1. Pipe shall be laid on undisturbed trench bottom provided suitable base is available:
   a. No rocks larger than 1 inch or with sharp edges
   b. Otherwise, excavate to 2-inch below pipe invert, install sand or crushed stone base

C. Backfilling
1. First 10 inches
   a. No foreign material or debris
   b. No rocks larger than 1-inch in diameter
   c. No frozen material
   d. Carefully place material around pipe and wire and tamp in place
2. Remaining Backfill
   a. Placed in maximum 6-inch lifts
   b. Tamped to compaction with mechanical equipment
   c. Compact backfill in trenches to dry density equal to adjacent undisturbed soil
   d. Match adjacent grades without hills or depressions and repair settling (as required by 1-Year Guarantee)
   e. Compaction by truck tires is prohibited
   f. Avoid backfilling of pipe in hot weather
3. Pipe pulling acceptable where soils are suitable and specified depth of bury can be maintained.

D. PVC Pipe Preparation
1. Cut plastic pipe with handsaw or pipe cutter, removing all burrs at cut ends. All pipe cuts shall be square and true. Bevel cut end as required to conform to manufacturer instructions.
2. Clean spigot ends and/or make all gasket joints as per manufacturer instructions (see Details).
3. Avoid excessive use of lubricant. Do not wipe off any excess lubricant from each connection.
4. Maximum deflection per joint shall not exceed manufacturer limits.
5. Make all solvent-weld joints as per manufacturer instructions and avoid applying excess primer or solvent. Do not wipe off excess solvent from each connection.
6. Allow welded joints 5 minutes set-up/curing time minimum before moving or handling.
   a. Above 80º F: Allow connections to set 24 hours before pulling or applying
   b. Below 80º F: Follow manufacturer instructions.
   c. Provide and install for expansion and contraction as recommended.
7. Wire shall run in same trench as mainline and at pipe invert (see Wire Installation)

E. Pipe Cover (over Unpaved Surfaces)
1. PVC Mainline = 24 inches

2. PVC Lateral = 16 inches

F. Pipe Protection
1. Prevent foreign material from entering pipe during installation.
2. Open ends of pipe shall be closed by watertight plug or seal when not in use.
3. Securely store pipe when not scheduled for installation.
4. No additional pipe may be installed or backfilled when water enters trench during pipe installation and may not resume until all water is removed from trench.
5. Pipe shall not be installed when water is in trench, during rainstorms, or when temperature is below 40º. Pipe installed at temperatures below 40º F shall be removed and replaced at no cost to Owner.
6. PVC pipe shall be snaked in trench to accommodate for expansion and contraction due to changes in temperature.

G. Coordination and Obstructions
1. Route pipe as necessary to prevent damage to tree roots. Where trenching must occur near trees, provide proper root pruning and sealing methods to all roots 1-inch and larger.
2. Maintain 6-inch minimum clearance between irrigation lines and lines of other trades. Do not install sprinkler lines directly above another line of any kind.
3. Maintain 1-inch minimum between lines which cross at angles of 45 to 90 degrees.
4. Exercise care when excavating, trenching and working near existing utilities.

3.03 PIPE SLEEVE INSTALLATION

A. Pipe sleeves shall be installed where pipe runs under hardscape (see Drawings).

B. Minimum cover over all pipe sleeves shall be 24 inches (see Drawings).

C. Pipe sleeves shall extend 18 inches beyond edges of walls and pavement (see Drawings).

D. Prior to installation of pipe, pipe sleeve ends shall be field marked with vertical wood stakes extending above grade to allow field location during irrigation system installation.

E. Ensure that all required pipe sleeves are installed prior to pavement or concrete installation. Review all sleeve locations in field with irrigation sub-contractor to confirm that sleeves are properly located for required irrigation pipe runs.

F. Cutting through or jacking under new pavement shall be strictly prohibited. Failure to provide sleeves shall notification to Owner's Representative for resolution (re-design or retrofit).

3.04 ELECTRICAL CONDUIT INSTALLATION

A. Electrical conduit shall be installed under all hardscape areas, above-ground wiring, under or through walls, walks and paving to controllers and external sensors.

B. Electrical conduit shall extend 18 inches beyond edges of walls and pavement (see Drawings)

3.05 ISOLATION VALVE INSTALLATION

A. Install isolation valves per detail where indicated on Drawings.

B. Install all isolation valves on level crushed stone base for operation ease with appropriate valve wrench.

C. Install specified valve box over each isolation valve.

D. Check and tighten valve bonnet packing before valve box and backfill installation.

3.06 VALVE BOX INSTALLATION

A. Furnish and install valve box as per valve schedule above for each valve, splice, or sensor.

B. Install valve boxes on minimum 4-inch crushed stone base. Pouring stone into valve box after installation is not acceptable.

C. Finish elevation of all boxes shall be at grade, unless otherwise noted in Drawings.

3.07 ELECTRIC ZONE VALVE INSTALLATION

A. Electric zone valves shall be installed on level crushed stone base. Grade of stone bases shall be consistent throughout project so that finish grades fall within limits of work.

B. Valves shall be set plumb with adjusting handle and all bolts, screws and wiring accessible through valve box opening.

C. Valves shall be set in plumb position with 24-inch minimum maintenance clearance from other equipment.

D. Install at sufficient depth to provide between 4 – 6 inches of cover from top of valve to finish grade.

E. Adjust zone valve operation after installation using flow control device on valve.

3.08 WIRE INSTALLATION

A. All valve two-wire shall be installed alongside mainline at invert.

B. Sufficient slack for expansion and contraction shall be maintained and wiring shall at no point be installed tightly. Provide and install additional 8 inches to 12 inches slack at all changes of direction for conventional wire from decoder to valve. Provide 30 inches slack on each side of decoder for two-wire.

C. Wire in valve boxes shall be of sufficient length to allow valve solenoid, splice, decoder wire, and all connections to be brought above grade for servicing. Slack shall be coiled for neatness in valve box. Each electric zone valve shall have separate wire back an in-field decoder. Each decoder shall be wired to two-wire from Automatic Irrigation Controller.

D. Wire shall be laid in trenches and carefully backfilled to avoid any damage to wire insulation or conductors. In areas of unsuitable material, trench shall have 2 inches layer of sand or stone dust on bottom before wires are laid into trench and back-filled. Wires shall have minimum of 12 inches of cover.

E. Store wire securely that is not scheduled for installation.

F. Service wiring in connection with Drawings and local codes for 24-volt service.

G. Provide grounding for two-wire system: 1 per 12 decoders or every 1,000 feet.

H. All in-ground wire connections shall be made waterproofed with 3M DBY-6 splice kits. All splices shall be made in valve boxes (wire runs requiring splices between valve locations shall be provided and installed in splice box-valve box shall be used).

I. Splice locations shall be shown on Record Drawings.

J. Provide complete wiring diagram showing wire routing for connections between controller and valves.

3.09 AUTOMATIC IRRIGATION CONTROLLER INSTALLATION

A. Irrigation Controller
1. Install controller outdoors where shown on Drawings. Wire valves and external sensor into controller and set proper program.
   a. Program “Cycle-Soak” feature for all zones with excessive slope or poorly draining soils
2. Using licensed electrician, wire controller to 120-Volt, 20-Amp electrical supply provided by Electrical Contractor.
3. After final walkthrough, turn keys over to Owner.

B. Flow Sensor
1. Install Flow Sensor where shown on Drawings in 12-inch standard valve box.
2. Flow Sensor shall have 30 inches (10 times pipe diameter) minimum of straight pipe upstream and 15 inches (5 times pipe diameter) minimum of straight pipe downstream to reduce turbulence.
3. Wire Flow Sensor to Automatic Irrigation Controller using 14AWG wire and DBY-6 connectors. No splices between Controller and Flow Sensor shall be allowed.

C. Grounding
1. Grounding Rod shall be driven into ground fully within 12 feet of controller.
2. Connect Rod to straight Grounding Wire with Cadweld connection. Minimum bending radius of Grounding Wire shall be 12 inches and bending angle of 90 degrees. Do not splice Grounding Wire.
3. Drive Grounding Rod below final grade and place 4-inch cover and grate over Rod top for routine maintenance.
4. Grounding Plate shall be installed 36 inches below grade with 50 lbs. of Ground Enhancement Material spread evenly below and above Plate.
5. Place 4-inch cover and grate over Grounding Plate (see Drawings).

3.10 SPRINKLER INSTALLATION

A. Rotor sprinklers shall be installed flush with grade on 1-inch PVC swing joint assemblies with integral “o” rings, 12 inches long minimum.
B. Rotor sprinklers shall not exceed maximum spacing as indicated on Drawings
C. Adjust all rotor sprinkler zones after installation using flow control device on valve.

3.11 QUICK COUPLING VALVE INSTALLATION

A. Quick coupling valves shall be installed as shown on Drawings; generally, at ends of mainline branches and immediately downstream of well.

B. Quick coupling valves shall be mounted on 1-Inch diameter, 12-inch long brass swing joint assemblies and stabilizers.

C. Install pressure regulating valves (to 40 psi) off mainline ductile iron service tee.

3.12 PRE-ACCEPTANCE ADJUSTMENTS

A. Install all pipe, sprinklers, valves, and equipment except sprinkler internals. Open electric zone valves and flush out irrigation system under full head of water. Only after flushing phase shall internals, flush caps, and nozzles be installed.

B. Flush entire irrigation system after complete installation. All clogged nozzles shall be remedied from 30 days after completion of irrigation system.

C. Test all pipe and valves for leaks at operating pressure. Repair all leaks and retest until leaks are remedied.

D. Perform coverage test with Owner's Representative present. Notify Owner's Representative at least 7 days in advance of scheduled coverage test. Coverage shall be to satisfaction of Owner's Representative. Readjust sprinkler nozzles and locations as directed to attain proper coverage.

E. Electric Zone Valves shall be operated for 5 minutes during which heads and patterns are acceptable for consistency. Any irrigation equipment that does not meet manufacturer standards shall be rejected, replaced, and retested until standards are met.

F. All testing shall be included in submitted bid price.

G. After testing, clean all equipment completely of pipe cuttings, oils, grease, and dirt accumulated during installation.

H. Adjust sprinkler heads and valve boxes to grade to not interfere with mowing and landscaping.

I. Throughout guarantee period, continually adjust sprinklers and coverage as necessary by settlement and operations.

3.13 RECORD DRAWINGS

A. Maintain and update record drawings with red lines markings as project progresses.

B. Record drawings shall document every change from original design Drawings.

C. Record drawings shall note exact locations and description of all sprinklers (nozzle, pop-up height, and type).

D. Record drawings shall reference each valve box by two permanent locations (swing ties).

E. Record drawings shall denote all equipment installed with distinct symbols.

F. Record drawings shall include wire routing and splice locations. Graphic symbol of wire routing shall be markedly distinct from mainline.

G. Prints of original Drawings may be obtained from Owner's Representative at cost (0% markup).

H. Record drawings shall be on-site at all times. Note following as project progresses:

1. Plumbing Permits (state whether or not required)
2. Materials Approved and approval date
3. Pressure Test results, testing personnel and testing date.
4. Materials Delivered, Accepted, and Installed by whom and date.

I. Record drawings shall be used as basis of payment for work completed. Provide copies of red-lined set to Owner's Representative along with payment request.

J. Make all notes legible as work progresses. Any new equipment added shall use distinct symbols denoting location. Record location of new equipment via swing ties and/or GPS.

K. Prior to final punchlist, provide complete electronic and hard copy files of Record Drawings to Owner's Representative as part of contract completion. All information must be complete and shall be added to submitted documents prior to acceptance.

3.14 OPERATION AND MAINTENANCE OVERVIEW AND MANUAL

A. Bid price shall include up to four (4) hours of irrigation system overview and instruction with Owner and/or Owner's designated irrigation manager. Overview shall be scheduled after pre-acceptance adjustments are completed and with seven (7) days advance notice.

B. Prior to application for acceptance and final payment, three (3) hard cover binders titled "Operation and Maintenance for Plymouth South High School Athletic Field Irrigation System" shall be provided to Owner's Representative for review. Once approved, copies of binders shall be forwarded to Owner.

C. Operation and Maintenance Manual shall include, but not be limited to:
1. Title Page and Table of Contents
2. One-Paragraph Written Description of Irrigation System
3. Manufacturers Data and Cut Sheets of Equipment, including:
   a. Copies of all approved submittals
   b. Recommended operating settings
   c. Recommended maintenance schedule
   d. Name, address, and telephone number of installer (for repairs, spring startup, and winterization during 1-year guarantee period)
   e. Name, address, and telephone number of recommended repair and service companies (beyond 1-year guarantee period)
   f. Irrigation program for periods without rain and recommended settings including, zone run time, days per week, cycle-soak, and rain sensor suspension
4. Winterization and Spring Startup Instructions
5. Guarantee Data
6. Pockets with Folded Plans of:
   a. Original Design Drawing
   b. Final Record Drawing
   c. Controller Valve and Wiring System Diagram Drawing

3.15 SITE CLEANUP

A. After installation and adjustment for coverage, leaks, operation, etc., remove all unused materials and equipment from project site safely and efficiently. Dispose of all unused materials legally including construction debris and general trash.

B. Adjust ground, compact, and re-plant around irrigation sprinkler heads as necessary to ensure proper angle and elevation.

C. Fill all depressions, erosion rills, tire tracks, etc. with proper planting soil mix to ensure proper site drainage.

3.16 FINAL OWNER ACCEPTANCE

A. Final Owner Acceptance of Irrigation System is predicated on:
1. Complete system installation, adjustment, testing, and instructional overview
2. Submission of Operation and Maintenance Manuals to Owner's Representative
3. Automatic Irrigation Controller properly programmed
4. Punchlist items are completed and approved by Owner's Representative

B. Owner and/or Owner's Representative shall provide written notice (hard copy and/or electronic) for Final Acceptance. Date of Final Acceptance notice shall serve as start of 1-Year Guarantee as described above

END OF SPECIFICATION

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Section 32 84 20
IRRIGATION WELL TESTING PROGRAM

PART 1 – PROJECT CONDITIONS

1.01 BACKGROUND

A. Plymouth South High School in Plymouth, MA seeks to source irrigation water for athletics fields fed by groundwater as its water source.

B. Specifications below are intended to outline testing for one (1) existing well

1.02 DEFINITIONS

A. OWNER: Town of Plymouth (MA)

B. CONTRACTOR – Entity awarded to perform work in this Specification

C. SPECIFICATIONS – Document below which outlines testing and reporting requirements of well redevelopment.

D. DRAWINGS – Plans issued by Owner's Representative.

E. TARGET YIELD – Desired water production based on irrigation system demand and existing well records equal to minimum sustainable yield of **300 gpm.**

1.03 GENERAL REQUIREMENTS

A. Contractor shall test existing well pump system to supply irrigation system to full extent and intention of Specification.

B. Contractor shall coordinate work of Specification with other underground utilities and with trades responsible for their installation and oversight.

1.04 SCOPE OF WORK

A. Existing Irrigation Well Testing
1. Furnish all labor, materials, equipment, and services required for testing of existing 18-inch irrigation well in unconsolidated formation at Plymouth South High School.
2. Use existing VFD Well Pump System controls (PLC set points, pressure transducer settings, frequency settings, etc.) to test existing well, well pump, and submersible motor. Control, pump and motor are approximately 3 – 5 years old.
3. Sever and repair existing mainline running from well pump house to existing baseball fields in order to perform testing.
4. Take water quality sample for analysis at Mass DEP approved laboratory (see testing constituents below).

1.05 CONTRACT CONDITIONS

A. Location of proposed work shall be as shown on Drawings and as directed by Owner and Engineers.

B. Drawings and Specifications must be interpreted and are intended to complement each other. Contractor shall furnish and install all parts, which may be required by Drawings and omitted by Specifications, or vice versa, just as though required by both. Should there

appear to be discrepancies or question of intent, Contractor shall refer matter to Owner and Engineer through written Request for Information (RFI). Owner's interpretations and decisions shall be final, conclusive and binding.

C. All materials to be incorporated shall be without flaws or defects and of quality and performance meeting requirements of Specification. All material overages at completion of installation are property of Contractor and shall be removed from site.

D. Work shall be constructed and finished in every respect in good, skillful, and substantial manner, to full intent and meaning of Drawings and Specifications. All parts necessary for proper and complete execution of work, whether same may have been specifically mentioned or not, or indicated on Drawings, shall be done or furnished in manner corresponding with rest of work as if same were specifically herein described.

1.06 EXCLUSIONS

A. Following work is NOT INCLUDED with this Specification:
1. Irrigation Sprinkler System

B. Contractor is responsible for providing equipment to test wells, namely:
1. Valves, pipes, orifices, etc
2. Metering equipment
3. Drawdown level monitoring equipment
4. Portable and/or Temporary Settling Basins for Well Development Discharge

1.07 ORDINANCES, PERMITS, CERTIFICATIONS, AND INSPECTIONS

A. Work described herein shall comply with all ordinances and regulations of authorities having jurisdiction, including all applicable local (Plymouth Board of Health), state (Mass DEP), and federal regulations.

B. Obtain and pay for all additional permits, tests, and certifications required for execution of work in Specification.

C. Furnish copies of permits, certifications, and approval notices to Owner prior to requesting final payment.

1.08 EXAMINATION OF SITE

A. Prospective Contractors shall fully inform themselves of site existing conditions before submitting bid, and shall be fully responsible for carrying out all work required, executing this Specification fully and properly. No claim for extra compensation or extension of time will be allowed due to actual conditions inconsistent with those assumed, unless approved by Owner and Engineers.

B. Access to land immediately surrounding existing well site shall be granted with sufficient working space for equipment operations.

C. Contractor shall coordinate with Owner and Engineer to inform and be informed of any hazards or obstructions which may affect location of wells, such as, but not limited to:
1. Overhead power lines
2. Buried cables
3. Buried pipes
4. Any known underground obstructions or contaminant not readily visible shall be identified

D. Avoid local depressions and low points that may collect or convey surface runoff.

1.09 BONDS AND INSURANCE (FOR REVIEW BY TOWN OF PLYMOUTH)

A. Surety and insurance companies shall be rated B+ or higher at time of Contact award by A.M. Best.

B. Coordinate all Insurance certificate submissions with General Contractor.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Store and handle all materials in compliance with manufacturers' instructions and recommendations.

B. Protect all existing equipment from all possible damage.

C. Minimize on-site storage and coordinate with Owner.

1.11 COORDINATION

A. Contractor shall coordinate work closely with Engineer and Owner at all times to avoid misunderstandings and to bring project to completion efficiently. Contractor shall also coordinate work with any approved subcontractors and other trades working on-site.

B. Contractor shall be held responsible for and pay for all unnecessary damage to property caused by employees or subcontractors. Repair work of such damage shall be coordinated with Owner.

PART 2 –EXISTING IRRIGATION WELL TESTING

2.01 INTRODUCTION

A. Specifications outline general testing of existing18-inch permanent well for irrigation water production at purported rate of 300 gpm.

2.02 QUALITY ASSURANCE

A. Testing Contractor
1. Firm that has been in business at least five (5) years performing work of size and type required by this Specification and which is acceptable to Owner.
2. Persons supervising proposed work of this Specification shall be personally experienced in well construction and shall have been regularly employed by company engaged in well construction for three (3) years minimum.
3. Furnish to Engineer names and addresses of five (5) similar projects with persons or entities installing and testing wells over past three (3) years (see Bid Sheet).

B. Disinfection
1. Conform to provisions of AWWA Standards A-100 and C-654 except where modified herein.
2. Maintain copy of these standards at all times on job site.

C. Applicable requirements of accepted Standards and Codes shall apply to Work of this Specification:
1. American Society for Testing & Materials (ASTM)
2. National Sanitary Foundation (NSF)
3. American Water Works Association (AWWA)
4. American Society of Agricultural and Biological Engineers (ASABE)

5. National Groundwater Association (NGWA)
6. Massachusetts Department of Conservation and Recreation (DCR)

2.03 TESTING SUBMITTALS

A. Upon completion of work and prior to application for acceptance and final payment, the following shall be submitted to Owner for approval (and for Phase B design verification) which includes:
1. Well Installation Logs and Data (both Test and Permanent Wells)
2. Yield Test Data (as specified herein)
3. Water Quality Test Data (as specified herein)

B. Other trades require this final data to begin additional phases of this project.

2.04 EXECUTION

A. GENERAL

1. Examine all contract documents applying to Specification noting any discrepancies and bringing same to attention of Engineer for timely resolution.
2. Make all field measurements necessary for work noting relationship of well work to other trades (coordinate with Owner).
2. At all times, protect existing landscaping, paving, structures, walls, footings, etc. from damage. Any inadvertent damage to work of another trade shall be reported at once.
3. All well yield testing shall be in strict accordance of this Specification.
4. Well testing shall be in strict accordance with ASABE EP 400.2T JAN 1994 (R2005) “Design and Constructing Irrigation Wells”.
5. All equipment and materials shall be placed in well meeting this Specifications, unless some good and sufficient reason is encountered during redevelopment requiring deviation. Contractor, Engineer, and Owner shall mutually agree upon changes. Written record shall be maintained.

B. YIELD AND DRAWDOWN TESTING
1. Well shall have three (3) phases of mandatory testing:
   a. Step drawdown test (4.5 hours)
   b. Constant pumping rate test (8.0 hours)
   c. Recovery test (0.5 hours)
2. Prior to commencement of testing, ensure that pump discharge is directed away from recharge zone surrounding well (coordinate with Owner or local permitting agencies).
3. Yield Testing
   a. Set temporary submersible pump inlet no lower than top of well screen
   b. Record static water level
   c. Begin pumping at 50% of Target Yield (150 gpm +/-)
   d. Record drawdown at following intervals:
      i. Every minute for first 10 minutes after pumping starts
      ii. Once every 10 minutes from 10 minutes to 90 minutes
   e. Increase pumping rate to 100% of Target Yield (300 gpm)
   f. Record drawdown at following intervals:
      i. Every minute for first 10 minutes after pumping starts
      ii. Once every 10 minutes from 10 minutes to 90 minutes
   g. Increase pumping rate to maximum pumping rate (> 300 gpm)
   h. Record drawdown at following intervals:
      i. Every minute for first 10 minutes after pumping starts

ii. Once every 10 minutes from 10 minutes to 90 minutes

i. Stop step drawdown test and allow well to recover to steady-state conditions. Record time to recovery.

4. Constant Pumping Rate Test
   a. Set temporary submersible pump inlet no lower than top of well screen
   b. Record static water level
   c. Begin pumping at 100% of required yield
   d. Record drawdown at following intervals:
      i. Every minute for first 10 minutes after pumping starts
      ii. Once every 10 minutes from 10 minutes to 120 minutes
      iii. Once every 30 minutes from 120 minutes to 480 minutes
   e. If yield test is stopped for more than 15 minutes, test must be abandoned and started from beginning allowing well to recover—THE COST OF TIME AND MATERIALS TO RESET TEST SHALL BE AT CONTRACTOR'S EXPENSE.
5. Recovery Tests
   a. At conclusion of constant pumping rate test, immediately begin recording well recovery depths from time pump is shut off.
   b. MINIMUM time for recovery test is 0.5 hours (30 minutes) OR when 95% of well has recovered, whichever is longer—NO EXCEPTIONS.
   c. Record recovered water levels at following intervals:
      i. Every minute for first 10 minutes after pumping starts
      ii. Once every 5 minutes from 10 minutes to 30 minutes (or until 95% recovery)
6. Data Reports
   a. Present drawdown and recovery data in legible (typed notes preferred) report with time and flow rates reported in corresponding columns for well.

C. WATER QUALITY TEST
1. Upon completion of yield testing of irrigation well, Contractor shall take water sample for physical, chemical, and bacteriological analysis. Sample shall be taken in presence of Owner.
2. Contractor shall make all necessary arrangements and promptly send samples either to local Health Department laboratory or to private laboratory that is approved by local Health Department.
3. Water quality analysis shall be conducted in accordance with standards and methods approved by local and State Health Departments, as well as United States Environmental Protection Agency. analysis shall include testing for following:
   a. Arsenic
   b. Boron
   c. Beryllium
   d. Cadmium
   e. Calcium
   f. Chromium
   g. Copper
   h. Iron (Total and Dissolved)
   i. Lead
   j. Magnesium
   k. Manganese
   l. Mercury
   m. Potassium
   n. Sodium
   o. Selenium
   p. Zinc

q. Chloride
r. Sulfate
s. Nitrate
t. Nitrite
u. Turbidity
v. Total Coliform Bacteria
w. pH
x. Hardness
y. Alkalinity (all forms)
z. Carbonate
aa. Bicarbonate
bb. Residual Chlorine
cc. Total Dissolved Solids
dd. Electrical Conductivity

4. Analysis must report constituents enumerated above. Incomplete analyses will be rejected.

D. ACCEPTANCE AND OPERATION

1. Upon completion of work and acceptance by Engineer and Owner, Contractor shall be responsible for providing all specified information.

E. CLEAN UP

1. Upon completion of all testing work, Contractor shall remove all leftover materials and equipment from site in safe and legal manner.
2. Contractor shall leave site clean and free of all debris generated from testing of irrigation well.

F. FINAL REPORT & NEW PUMP

1. Provide a final bound report to Owner for review by Engineer to determine if existing pump is sufficient for proposed irrigation.
2. If existing pump end is insufficient, new pump end shall be Goulds 250L approved equal.
3. Existing motor end is 50-hp and sufficient for proposed irrigation.

END OF SPECIFICATION

Section 32 92 00
SOIL PREPARATION FOR LAWN ESTABLISHMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related Sections: The following Sections contain requirements that relate to this Section:
1. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
2. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
3. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

1.2 DESCRIPTION OF WORK

A. Provide all materials, equipment and labor necessary to complete the work as indicated on the drawings or as specified herein.

B. The principal work of this section includes, but may not be limited to, the following:
1. Grading and Spreading Loam.
2. Preparations of Areas for Seeding.
3. Application of Limestone.
4. Application of Lawn Starter Fertilizer.
5. Application of Turf Maintenance Fertilizer.
6. Applying Jute Mesh.

1.3 QUALITY ASSURANCE

A. Contractor shall specialize in work outlined with a minimum of five (5) years experience on similar projects.

B. Do not make substitutions without written approval. If specified materials are not available, obtain approval for substitution from the Owner's Representative.

1.4 SUBMITTALS

A. The Contractor shall submit representative samples, manufacturer's product data, source of off-site loam to be provided, and certified test results for materials as specified below. Certification shall list soil additives to loam including rates and type.

B. Existing On-Site loam: Sample and test existing on-site loam. The Contractor shall sample the existing loam soils from the construction site with the following requirements:

1. The contractor shall provide a one cubic foot representative sample per each 1,000 cubic yard on-site stockpile of existing loam for testing. All stockpile sampling shall be per ASTM D 75 and Appendixes.

2. Preparation of Samples: Contractor shall place these soil slices into a large, clean plastic container and mix thoroughly. Contractor shall take one cup of soil mixture and dry it room temperature (do not dry samples in an oven or on a stove or radiator). Once soil is dry, place soil in sandwich size type plastic bag and close. Label each sample on outside of bag, identifying sample by soil type and acre.

C. Loam from off-site, if on-site is insufficient: The Contractor shall provide a one cubic foot representative sample per each 1,000 cubic yard proposed stockpile of loam borrow for testing. All stockpile sampling shall be per ASTM D 75 and Appendixes.

D. All testing shall be at the expense of the contractor. Contractor shall deliver samples to the testing facility and have the results forwarded to the Architect. Perform all tests for gradation, organic content, soil chemistry and pH. Testing reports shall include the following tests and recommendations:

1. Mechanical gradation (sieve analysis) shall be performed and compared to the USDA Soil Classification System.
2. Chemical Analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Lead, Zinc, Soluble Salts, extractable Aluminum, Cadmium, Copper, pH and buffer pH. Except where otherwise noted, nutrient tests shall be for available nutrients.
3. Soil analysis tests shall show recommendations for soil additives to correct soils to meet the specifications and for additives necessary to accomplish lawn work as specified.
4. Permeability rates for materials.

E. Compost: Submit supplier's certification of contents.

F. Certification and/or labels of proposed soil additives stating names of each.

G. Sustainable Design Submittals:
1. Recycled content: Provide manufacturer's written certification of recycled content as defined in accordance with International Standard ISO 14021–1999, Environmental Labels and Declarations—Self-Declared Environmental Claims (Type II Environmental Labeling). Indicate post-consumer and pre-consumer recycled content and provide documentation certifying products are from recycled sources. (LEED Credit MRc4).

2. Local/regional materials (LEED Credit MRc5):
   a. Indicate location of content of extraction, harvesting, and recovery; indicate the distance between extraction, harvesting, and recovery and the project site. Indicate percentage of product content from qualified locations.
   b. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
3. Adhesives and Sealants: Include certification of data indicating Volatile Organic Compound (VOC) content of all field-applied adhesives and sealants and compliance with California Department of Health Services Standard Practice for the Testing of

Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda. Submit MSDS highlighting VOC limits. (LEED Credit IEQc4.1).

1.5 DEFINITIONS

A. The following definitions shall apply to the work of this section.

The following size distributions of mineral particles by diameter and sieve size shall apply to the following conventional names of soil types:

Conventional Name	Retained on US Sieve No.	Diameter (mm)
Very Coarse Sand	#18	1-2
Coarse Sand	#35	0.5-1
Medium Sand	#60	0.25-0.5
Fine Sand	#140	0.10-0.25
Very Fine Sand	#270	0.05-0.10
Silt	by hydrometer	0.002-0.05
Clay	by hydrometer	Less than 0.002

1.6 PRODUCT DELIVER, STORAGE AND HANDLING

A. Protect all products from weather vandalism or other damaging or deteriorating conditions.

PART 2 - PRODUCTS

2.1 CLEAN SCREENED LOAM

A. Loam shall consist of screened fertile, loose, friable fine sandy loam or sandy loam free of subsoil, refuse, stamps, roots, rocks, cobbles, stones, brush, noxious weeds, litter and other materials which are larger than 1/2 inch (1/2”) in any dimension and which will prevent healthy plant growth.

B. Loam shall be one of the following sandy loams: “coarse sandy loam”, “sandy loam”, “fine sandy loam” based on the USDA Classification System determined by mechanical analysis ASTM D-422. It shall be uniform in composition, without admixture of subsoil. The loam shall possess good filtration and permeability rates, and shall possess a mechanical analysis where:

Sand (0.05 to 2.0 mm)	60% - 70% with no less than 70% of the sand in the medium through very coarse sand fractions (0.25 – 2 mm)
Silt (0.002 to 0.05 mm)	15%-25%
Clay (< 0.002)	10%-20%
Gravel (> 2.0 mm)	<15%

Maximum size shall be three eighths (3/8”) inches largest diameter.

C. Organic Content and pH: Loam shall contain not less than 3% or more than 6% organic matter

D. Acidity range shall be pH 6 to 7.5 in seeded areas when tested according to methods of testing or A.O.A.C.

1. Loam Borrow shall be pH adjusted for particular planting applications and shall be adjusted prior to delivery to the project site.

a. When pH of loam is equal to or greater than 7.5 use aluminum sulfate to adjust pH to required levels.

b. When pH of loam is less than 6 use either sulfur or ferrous sulfate to adjust pH to required levels.

E. The loam borrow must not be handled or moved when in wet or frozen conditions.

F. Loam shall be uncontaminated by salt water, foreign matter and substances harmful to plant growth. Topsoil shall not have extractable aluminum greater than 200 parts per million unless otherwise noted. Cation Exchange Capacity (CEC) shall be between 10 and 15.

G. Loam should yield a saturated hydraulic conductivity value of 1 to 2 inches per hour.

2.2 LIMESTONE

A. Dolomitic limestone contain up to 50% magnesium carbonate in a dry, granular form. Limestone shall be ground to such a fineness that at least 50% will pass through a 100-mesh sieve and 90% to 100% will pass through a 20-mesh sieve.

2.3 LAWN STARTER AND MAINTENANCE FERTILIZER

A. Fertilizer shall be Organic-based and be OMRI (Organic Materials Review Institute) Certified
B. Complete fertilizer in granular form, from commercial sources bearing manufacturer's analysis; 2-3-3 ratio of N-P-K.
1. Total Nitrogen (N) – 2.0%
a. 0.8% - Water Soluble Nitrogen
b. 1.2% - Water Insoluble Nitrogen
2. Available Phosphate (P_2O_5) – 3.0%
3. Soluble Phosphate (K_2O) – 3.0%
C. Application Rate: Apply 2-3 pounds per 100 square feet

2.4 JUTE MESH

A. Jute mesh shall be uniform, open, plain weave of undyed and unbleached single jute yarn, a minimum of four (4) feet in width plus or minus one (1) inch. There shall be 78 warp ends per width and 41 weft ends per yard. Weight shall average 1.22 pounds per linear yard, plus or minus 5%.

B. Staples for Erosion Control Materials: 9 gauge staples shall be used with jute mesh: 11 gauge with woven paper.

2.5 WATER

A. Clean, fresh potable water.

PART 3 - EXECUTION

3.0 GRADING AND SPREADING LOAM

A. Remove all debris and other inorganic materials on any prepared subgrades, and reshape and dress any damaged or eroded slopes, swales, and other areas. Scarify and loosen subgrade to a friable condition in any areas where compaction may have occurred. Loam shall not be placed until subgrade is in suitable condition and free of excessive moisture or frozen materials.

B. Loam shall be spread on all disturbed and bare areas to produce a total depth of **6"** as shown on the plan. Fill all depressions in existing grades with suitable fill material as specified in Section 31 00 00 prior to spreading loam, then shape and finish grade to depth of loam required.

C. Area shall be progressively fine graded and machine and hand raked, with loam added to correct depressions and other irregularities, to produce smooth and unbroken finish grades and the depth of loam required.

D. Drawings show grading design intent to achieve a uniform grade not less than 1.25% slope. Finish grades shall conform to lines, grades, sections, and shapes of lawn areas. Provide positive drainage. Provide smooth, uniform, rounded transitions at all changes and break in grade. Loam is to be consistent depth of 1/2" below adjacent pavements surfaces.

E. Starter fertilizers: All required materials shall be spread and distributed into the soil at rates and amounts specified herein.

F. After establishment of finish grade, entire area shall be hand raked and rolled using a light roller.

3.1 PREPARATION OF AREAS FOR SEEDING

A. GENERAL DESCRIPTION: This work shall consist of the preparation of the seed bed. Work shall be done as described herein:
1. Areas shall be finely raked to a finished grade. Substantially, all sticks, litter, wire, weeds, cable or stones larger than one (1") inch in greater dimension shall be removed and disposed of.
2. Where the soil has become compacted, prior to fine raking, areas to be seeded shall be scarified by discing, york raking, or other approved method to a minimum depth of two (2) inches.
3. No seeding will be permitted on areas where the seed bed has not been properly prepared or where the soil is compacted.
4. Request inspection of the work for approval before proceeding with seeding.

3.2 APPLICATION OF LIMESTONE

A. When applied dry, limestone shall be spread evenly and incorporated thoroughly into the soil by discing or other approved means.

B. When applied hydraulically, no discing will be necessary.

C. Granular treatment to be applied at the rate of 25 to 50 lbs. per 1,000 square feet or by soil pH test to

produce a pH of 6.0 to 6.5.

3.3 APPLICATION OF STARTER AND MAINTENANCE FERTILIZER

A. One application of turf maintenance fertilizer will be required before final acceptance of seeded areas.

B. Fertilizer shall be Organic-based and be OMRI (Organic Materials Review Institute) Certified

C. Application Rate: Apply 2-3 pounds per 100 square feet.

D. Fertilizer shall be applied at a time, which shall be requested in writing by the Contractor, and approved in writing by the Owner's representative.

3.4 APPLYING JUTE MESH

A. Apply jute mesh loosely but smoothly to fit the contour of the finished grade, parallel to and in same direction as the flow of water. The up-slope end of the each separate strip or piece of jute mesh shall be buried in a six (6) inch minimum vertical anchor slot of junction slot with the soil tamped firmly against the mesh. Where more than one width of material is required, edges shall overlap a minimum of twelve (12) inches, and the up-slope section of mesh will be on top. Down-hill ends of the jute mesh shall be folded under approximately four (4) inches and stapled in place. Staples will be inserted through the mesh along edges, overlaps, and in the center of all jute mesh strips at intervals not greater than three (3) feet. All anchor slots, junction slots, check slots, and terminal folds shall have five (5) staples spaced not more than nine (9) inches on center across widths.

B. On seeded banks, jute shall be applied immediately after seeding. On shrub banks, apply jute after finish grading. Cut openings in mesh for each plant and plant and mulch as specified.

END OF SECTION

Section 32 92 10
SOIL PREPARATION FOR ATHLETIC FIELDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related Sections: The following Sections contain requirements that relate to this Section:
1. 31 11 00 – Site Preparation
2. 31 00 00 - Earthwork

1.2 DESCRIPTION OF WORK

A. Provide all materials, equipment and labor necessary to complete the work as indicated on the drawings or as specified herein.

B. The principal work of this section includes, but may not be limited to, the following:
1. Loam from off-site, if on-site is insufficient.
2. Grading and Spreading Loam.
3. Preparations of Areas for Seeding.
4. Application of Limestone.
5. Application of Lawn Starter Fertilizer.
6. Application of Turf Maintenance Fertilizer.
7. Applying Jute Mesh.

1.3 MINIMUM REQUIREMENTS

A. The successful bidder shall meet the following minimum requirements in order to be considered for installation of the athletic fields. **All requirements listed in 1.3 MINIMUM REQUIREMENTS shall be documented and submitted to the Architect for approval prior to commencement of any athletic field work.**
1. Selected installer must have installed fields greater than three (3) years old of similar materials and design. **Documentation of this shall be furnished per 1.3, A above.**
2. Selected installer must install athletic fields using his/her own crews, subcontracting of installation work will not be allowed.
3. Selected installer must have a minimum of five (5) outdoor fields at over 50,000 square feet each installed in the Northeast United States of similar construction. **A list of these installations with owner's name and phone number shall be furnished per 1.3, A above.**
4. Selected installer must have a minimum of five (5) years' experience in the installation of athletic fields. The crew foreman shall have installed a minimum of five (5) similar installations. **A list of previous projects installed by foreman shall be furnished per 1.3, A above.**

1.4 QUALITY ASSURANCE

A. The approved installer shall meet with the Site Contractor and General Contractor to review the following:
   1. Review the entire system including subgrade, base, utilities, and drainage to ensure all components are complimentary.
   2. Installation of the athletic field shall be done only after excavation and construction work which might injure it has been complete. Damage caused during construction shall be repaired prior to acceptance.

B. Do not make substitutions without written approval. If specified materials are not available, obtain approval for substitution from the Owner's Representative.

1.5 SUBMITTALS

A. At least 30 days to ordering material, the Contractor shall submit to the Architect representative samples, manufacturer's product data, source of off-site loam to be provided, and certified test results for materials as specified below. Certification shall list soil additives to loam including rates and type.

B. Existing On-Site loam: Sample and test existing on-site loam. The Contractor shall sample the existing loam soils from the construction site with the following requirements:

   1. The contractor shall provide a one cubic foot representative sample per each 1,000 cubic yard on-site stockpile of existing loam for testing. All stockpile sampling shall be per ASTM D 75 and Appendixes.

   2. Preparation of Samples: Contractor shall place these soil slices into a large, clean plastic container and mix thoroughly. Contractor shall take one cup of soil mixture and dry it room temperature (do not dry samples in an oven or on a stove or radiator). Once soil is dry, place soil in sandwich size type plastic bag and close. Label each sample on outside of bag, identifying sample by soil type and acre.

C. Loam from off-site, if on-site is insufficient: The Contractor shall provide a one cubic foot representative sample per each 1,000 cubic yard proposed stockpile of loam borrow for testing. All stockpile sampling shall be per ASTM D 75 and Appendixes.

D. All testing shall be at the expense of the contractor. Contractor shall deliver samples to the testing facility and have the results forwarded to the Architect. Perform all tests for gradation, organic content, soil chemistry and pH. Testing reports shall include the following tests and recommendations:

   1. Mechanical gradation (sieve analysis) shall be performed and compared to the USDA Soil Classification System.
   2. Chemical Analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Lead, Zinc, Soluble Salts, extractable Aluminum, Cadmium, Copper, pH and buffer pH. Except where otherwise noted, nutrient tests shall be for available nutrients.
   3. Soil analysis tests shall show recommendations for soil additives to correct soils to meet the specifications and for additives necessary to accomplish lawn work as specified.
   4. Permeability rates for materials.

E. Compost: Submit supplier's certification of contents.

F. Certification and/or labels of proposed soil additives stating names of each.

G. Sustainable Design Submittals:
1. Recycled content: Provide manufacturer's written certification of recycled content as defined in accordance with International Standard ISO 14021–1999, Environmental Labels and Declarations—Self-Declared Environmental Claims (Type II Environmental Labeling). Indicate post-consumer and pre-consumer recycled content and provide documentation certifying products are from recycled sources. (LEED Credit MRc4).

2. Local/regional materials (LEED Credit MRc5):
a. Indicate location of content of extraction, harvesting, and recovery; indicate the distance between extraction, harvesting, and recovery and the project site. Indicate percentage of product content from qualified locations.
b. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
3. Adhesives and Sealants: Include certification of data indicating Volatile Organic Compound (VOC) content of all field-applied adhesives and sealants and compliance with California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda. Submit MSDS highlighting VOC limits. (LEED Credit IEQc4.1).

1.6 DEFINITIONS

A. The following definitions shall apply to the work of this section.

The following size distributions of mineral particles by diameter and sieve size shall apply to the following conventional names of soil types:

Conventional Name	Retained on US Sieve No.	Diameter (mm)
Very Coarse Sand	#18	1-2
Coarse Sand	#35	0.5-1
Medium Sand	#60	0.25-0.5
Fine Sand	#140	0.10-0.25
Very Fine Sand	#270	0.05-0.10
Silt	by hydrometer	0.002-0.05
Clay	by hydrometer	Less than 0.002

1.7 PRODUCT DELIVER, STORAGE AND HANDLING

A. Protect all products from weather vandalism or other damaging or deteriorating conditions.

PART 2 - PRODUCTS

2.1 CLEAN SCREENED LOAM

A. Loam shall consist of screened fertile, loose, friable fine sandy loam or sandy loam free of subsoil,

refuse, stamps, roots, rocks, cobbles, stones, brush, noxious weeds, litter and other materials which are larger than 1/2 inch (1/2") in any dimension and which will prevent healthy plant growth.

B. Loam shall be one of the following sandy loams: "coarse sandy loam", "sandy loam", "fine sandy loam" based on the USDA Classification System determined by mechanical analysis ASTM D-422. It shall be uniform in composition, without admixture of subsoil. The loam shall possess good filtration and permeability rates, and shall possess a mechanical analysis where:

Sand (0.05 to 2.0 mm)	65% - 75% with no less than 70% of the sand in the medium through very coarse sand fractions (0.25 – 2 mm)
Silt (0.002 to 0.05 mm)	15%-25%
Clay (< 0.002)	10%-20%
Gravel (> 2.0 mm)	<15%

Maximum size shall be three eighths (3/8") inches largest diameter.

C. Organic Content and pH: Loam shall contain not less than 3% or more than 6% organic matter

D. Acidity range shall be pH 6 to 7.5 in seeded areas when tested according to methods of testing or A.O.A.C.

1. Loam Borrow shall be pH adjusted for particular planting applications and shall be adjusted prior to delivery to the project site.

a. When pH of loam is equal to or greater than 7.5 use aluminum sulfate to adjust pH to required levels.

b. When pH of loam is less than 6 use either sulfur or ferrous sulfate to adjust pH to required levels.

E. The loam borrow must not be handled or moved when in wet or frozen conditions.

F. Loam shall be uncontaminated by salt water, foreign matter and substances harmful to plant growth. Topsoil shall not have extractable aluminum greater than 200 parts per million unless otherwise noted. Cation Exchange Capacity (CEC) shall be between 10 and 15.

G. Loam should yield a saturated hydraulic conductivity value of 1 to 2 inches per hour.

2.2 SOIL ADDITIVES

A. Dolomitic Limestone: contain up to 50% magnesium carbonate in a dry, granular form. Limestone shall be ground to such a fineness that at least 50% will pass through a 100-mesh sieve and 90% to 100% will pass through a 20-mesh sieve.

B. Aluminum Sulfate: shall be unadulterated, 57%.

C. Lawn Starter and Maintenance Fertilizer:

1. Fertilizer shall be Organic-based and be OMRI (Organic Materials Review Institute) Certified

2. Complete fertilizer in granular form, from commercial sources bearing manufacturer's analysis; 2-3-3 ratio of N-P-K.

    a. Total Nitrogen (N) – 2.0%
    b. 0.8% - Water Soluble Nitrogen
    c. 1.2% - Water Insoluble Nitrogen
    d. Available Phosphate (P2O5) – 3.0%
    e. Soluble Phosphate (K2O) – 3.0%

3. Application Rate: Apply 2-3 pounds per 100 square feet

D. Sand: Shall be clean, course, ungraded material meeting ASTM C33 requirements for masonry sand, with the following addendums:

E. The sand shall have a fineness modulus of 2.5 to 3.2.

F. A coefficient of uniformity (D60/D10) of less than 4.

G. Compost: Compost may be used, compost shall be derived from the following:

H. Yard Debris: Compost made from yard trimmings, such as leaves, grass clippings and pruning that have been properly composted, are mature and have been sieved through a ¾ inch screen shall be free of trash and contain no toxic substances harmful to plant growth Compost and/or biosolids compost/compost sludge.

I. Biosolids Compost/Compost Sludge: Compost made from biosolids are mature and have been sieved through a ¾ inch screen. The pH range shall be 6.2-7.2

J. All compost provided shall have the following properties:

K. Organic matter content of no less than 30% as determined by ASTM D2974.
L. A moisture content of 35%-70%, as determined by ASTM D2974.
M. A carbon/nitrogen ratio of 15:1 to 30:1.
N. Soluble salts not to exceed 3 dS/m.
O. A Solvita Index of 6 to 8.
P. A pH of 6 to 8.
Q. Non-phytotoxic.

R. Humus: Shall be natural humus, free from excessive amounts of zinc, low in wood content, free from hard lumps and in a shredded or granular form. The acidity range shall be approximately 5.5 pH to 7.5 pH and the organic matter shall not be less than 85% as determined by loss on ignition. The minimum water absorbing ability shall be 200% by weight on an oven-dry basis.

S. Bone Meal: shall be fine ground, steam cooked, packing house bone with a minimum analysis of 23% phosphoric acid and 4% nitrogen.

T. Jute Mesh: Jute mesh shall be uniform, open, plain weave of undyed and unbleached single jute yarn, a minimum of four (4) feet in width plus or minus one (1) inch. There shall be 78 warp

ends per width and 41 weft ends per yard. Weight shall average 1.22 pounds per linear yard, plus or minus 5%. Staples for Erosion Control Materials: 9 gauge staples shall be used with jute mesh: 11 gauge with woven paper.

2.3 WATER

H. Clean, fresh potable water.

PART 3 - EXECUTION

3.0 GRADING AND SPREADING LOAM

A. Remove all debris and other inorganic materials on any prepared subgrades, and reshape and dress any damaged or eroded slopes, swales, and other areas. Scarify and loosen subgrade to a friable condition in any areas where compaction may have occurred. Loam shall not be placed until subgrade is in suitable condition and free of excessive moisture or frozen materials.

B. Loam shall be spread as specified on all disturbed and bare areas to produce a total depth of 6" as shown on the plan. Fill all depressions in existing grades with suitable fill material as specified in Section 31 00 00 prior to spreading loam, then shape and finish grade to depth of loam required.

C. Area shall be progressively fine graded and machine and hand raked, with loam added to correct depressions and other irregularities, to produce smooth and unbroken finish grades and the depth of loam required.

D. Drawings show grading design intent to achieve a uniform grade not less than 1.25% slope. Finish grades shall conform to lines, grades, sections, and shapes of lawn areas as shown on the plans. Provide positive drainage. Provide smooth, uniform, rounded transitions at all changes and break in grade. Loam is to be consistent depth of 1/2" below adjacent pavements surfaces.

E. Starter fertilizers: All required materials shall be spread and distributed into the soil at rates and amounts specified herein.

F. After establishment of finish grade, entire area shall be hand raked and rolled using a light roller.

3.1 PREPARATION OF AREAS FOR SEEDING

A. GENERAL DESCRIPTION: This work shall consist of the preparation of the seed bed. Work shall be done as described herein:
   1. Areas shall be finely raked to a finished grade. Substantially, all sticks, litter, wire, weeds, cable or stones larger than one half (1/2") inch in greater dimension shall be removed and disposed of per the contract specifications.
   2. Where the soil has become compacted, prior to fine raking, areas to be seeded shall be scarified by discing, york raking, or other approved method to a minimum depth of two (2) inches.
   3. No seeding will be permitted on areas where the seed bed has not been properly prepared or where the soil is compacted.

4. Request inspection of the work for approval before proceeding with seeding.

3.2 APPLICATION OF LIMESTONE

A. When applied dry, limestone shall be spread evenly and incorporated thoroughly into the soil by discing or other approved means.

B. When applied hydraulically, no discing will be necessary.

C. Granular treatment to be applied at the rate of 25 to 50 lbs. per 1,000 square feet or as required by soil pH test to produce a pH of 6.0 to 6.5.

3.3 APPLICATION OF STARTER AND MAINTENANCE FERTILIZER

A. One application of turf maintenance fertilizer will be required before final acceptance of seeded areas.

B. Fertilizer shall be Organic-based and be OMRI (Organic Materials Review Institute) Certified

C. Application Rate: Apply 2-3 pounds per 100 square feet.

D. Fertilizer shall be applied at a time, which shall be requested in writing by the Contractor, and approved in writing by the Owner's representative.

3.4 APPLYING JUTE MESH

A. Apply jute mesh loosely but smoothly to fit the contour of the finished grade, parallel to and in same direction as the flow of water. The up-slope end of the each separate strip or piece of jute mesh shall be buried in a six (6) inch minimum vertical anchor slot of junction slot with the soil tamped firmly against the mesh. Where more than one width of material is required, edges shall overlap a minimum of twelve (12) inches, and the up-slope section of mesh will be on top. Down-hill ends of the jute mesh shall be folded under approximately four (4) inches and stapled in place. Staples will be inserted through the mesh along edges, overlaps, and in the center of all jute mesh strips at intervals not greater than three (3) feet. All anchor slots, junction slots, check slots, and terminal folds shall have five (5) staples spaced not more than nine (9) inches on center across widths.

B. On seeded banks, jute shall be applied immediately after seeding. On shrub banks, apply jute after finish grading. Cut openings in mesh for each plant and plant and mulch as specified.

END OF SECTION

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Section 32 92 20
SEEDING FOR LAWN AREAS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related Sections: The following Sections contain requirements that relate to this Section:
1. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
2. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
3. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

1.2 DESCRIPTION OF WORK

A. Provide all materials, equipment, and labor necessary to complete the work as indicated on the drawings or as specified herein.

B. The principal work of this section includes, but may not be limited to, the following:
1. Application of seed.
2. Application of weed control.
3. Acceptance of seeding.

C. In general, seeded areas shall, at a minimum, include all areas of site within project limit lines that have been disturbed or are barren unless otherwise noted on the plans. Overseeding of established lawn areas, if required on plans, shall also extend to the limit of disturbance (LOD), unless otherwise noted.

1.3 QUALITY ASSURANCE

A. Subcontract seeding work to a firm specializing in such work unless Contractor is fully experienced and qualified.

B. Each seed bag or container shall display a label which identifies the contents as a true representation of the seed mix and percentages required by specification. No seed shall be applied to a site until the Owner's representative has determined the mixture meets all requirements.

C. Do not make substitutions without written approval. If specified seed mixes are not available, obtain approval for substitution from the Owner's representative.

1.4 SUBMITTALS

A. Certifications and/or labels of proposed seed mixtures stating common and scientific names of grasses, percentages by weight, and percentages of purity and germination.

B. Product information of all proposed weed control chemicals.

C. Sustainable Design Submittals:

1. Recycled content: Provide manufacturer's written certification of recycled content as defined in accordance with International Standard ISO 14021–1999, Environmental Labels and Declarations—Self-Declared Environmental Claims (Type II Environmental Labeling). Indicate post-consumer and pre-consumer recycled content and provide documentation certifying products are from recycled sources. (LEED Credit MRc4).

2. Local/regional materials (LEED Credit MRc5):

a. Indicate location of content of extraction, harvesting, and recovery; indicate the distance between extraction, harvesting, and recovery and the project site. Indicate percentage of product content from qualified locations.

b. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.

3. Adhesives and Sealants: Include certification of data indicating Volatile Organic Compound (VOC) content of all field-applied adhesives and sealants and compliance with California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda. Submit MSDS highlighting VOC limits. (LEED Credit IEQc4.1).

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect all products from weather or other damaging or deteriorating conditions.

B. Seed mixes which have been damaged or have deteriorated in transit or storage are not acceptable.

C. Seeding Schedule: Prepare a proposed seeding schedule. Schedule dates for each type of landscape work during normal seasons for such work.

Seeding: March 15 - June 30
August 15 - October 15

D. Correlate with specified maintenance periods to provide maintenance to date of acceptance. Once the schedule is accepted, dates shall be revised and submitted in writing for reasons of delay.

1.6 WARRANTY

A. Warranty seeding until final acceptance of grass stand.

PART 2 - PRODUCTS

2.1 SEED

A. General: Pure, live, fresh seed from commercial sources meeting and labeled in accordance with State and Federal laws, rules and regulations. All seed to have minimum germination rate of 85%.

1. Seed mix for all **general lawn areas** shall conform to the following grass types and percentages:

Improved Perennial Rye	25%
Improved Annual	25%
Creeping Red Fescue	25%
Turf Type Tall Fescue	18.5%
Kentucky Bluegrass 98/85	5%
Red Top	1%
Colonial Bentgrass	0.5%

Sowing Rate: 5 to 7 pounds per 1,000 sq. ft.
Overseed Sowing Rate: 2 to 3 pounds for 1,000 sq. ft.

2. Seed mix for **athletic fields** shall conform to the following grass types and percentages:

Improved Perennial Rye	30%
Improved Kentucky Bluegrass CGT	25%
Improved Kentucky Bluegrass CBT	25%
Chewing Fescue	20%

Sowing Rate: 4 to 6 pounds per 1,000 sq.ft.
Overseed Sowing Rate: 2 to 3 pounds for 1,000 sq. ft.

2.2 WEED CONTROL

A. Pre-emergent weed control for Loam and Seed Areas shall be Treflan 5-G or approved equal. Deliver in manufacturer's fully identified containers and apply according to manufacturer's directions.

2.3 WATER

A. Clean, fresh potable water.

PART 3 - EXECUTION

3.1 GENERAL

A. Seeded areas shall, at a minimum, include all areas of site within project limit lines that have been disturbed or are barren unless otherwise noted on the plans.

3.2 APPLICATION OF SEED

A. The approved seed mixture shall be applied at a rate per the sowing rate indicated in section 2.1 of this specificationt by means of seeder device capable of penetrating ground to depth of 1". Seeder machine shall be equipped with disc-type penetrating action and seeder tubes which plant seeds. Seeder shall be similar to Jacobson Model 524-100, 548100 or equal.

B. Distribute seed over area in two separate passes, each one perpendicular to the other (north-south, east-west orientation). Each pass shall be in a linear progression, and shall conform to the field direction that permits the longest straight line application procedure.

C. Hydroseeding will be permitted only with permission of the Owner. All requests shall be in writing with detailed and itemized procedures to be followed.

D. Broadcast seeding will be permitted only with permission of Owner. All requests shall be in writing with detailed and itemized procedure to be followed.

3.3 APPLICATION OF FERTILIZER

A. Fertilizer shall be Organic-based and be OMRI (Organic Materials Review Institute) Certified
B. Complete fertilizer in granular form, from commercial sources bearing manufacturer's analysis; 2-3-3 ratio of N-P-K.
   1. Total Nitrogen (N) – 2.0%
      a. 0.8% - Water Soluble Nitrogen
      b. 1.2% - Water Insoluble Nitrogen
   2. Available Phosphate (P2O5) – 3.0%
   3. Soluble Phosphate (K2O) – 3.0%
C. Application Rate: Apply 2-3 pounds per 100 square feet

3.4 ACCEPTANCE OF SEEDING FOR GENERAL LAWN AREAS

A. PROVISIONAL ACCEPTANCE
Provisional acceptance period shall be defined as the elapsed time between application of seed and the establishment of a good, healthy uniform growth of grass. Provisional acceptance will only be granted after one full growing season as indicated in Section 1.5

   1. Provisional acceptance will not occur until the seeded areas are well established, exhibiting a vigorous growing condition, devoid of bare spots greater than 1 square foot.
   2. It will be the contractor's responsibility to maintain seeding areas in an approved condition until provisional acceptance.
   3. The Contractor shall keep all seeded areas watered and in good condition, reseeding if and when necessary during the provisional acceptance period.
   4. Watering of seeded areas.
      a. During this period, water grass as necessary to maintain an adequate supply of moisture within the root zone. An adequate supply of moisture is the equivalent of one (1") of absorbed water per week that is delivered at weekly intervals in the form of natural rain or is augmented by periodic watering.
   5. It shall be the contractor's responsibility to obtain necessary documentation to show that provisional acceptance has been granted. This shall be done upon written request submitted by the contractor to the landscape architect to inspect grass work on site. Provisional acceptance will not be granted until contractor has obtained, in writing, a statement from the landscape architect indicating that grass is satisfactory under the terms of the provisional acceptance.

B. FINAL ACCEPTANCE FOR GENERAL LAWN AREAS
Final acceptance period shall be defined as the elapsed time between provisional acceptance and final closeout of the project.
   1. All seeded areas shall be guaranteed by the Contractor for not less than one growing season from the time of provisional acceptance. Growing season shall be defined as follows:
      a) If provisional acceptance is received during April, May, June or July, next growing season shall end on October 15.
      b) If provisional acceptance is received during September, October, November or December, next growing season shall end on June 1.
   2. At the end of the guarantee period, inspection will be made by the landscape architect upon written request submitted by the Contractor at least ten (10) days before the anticipated date. Grass areas not demonstrating satisfactory stands as outlined above, (except if damaged by vandalism) as determined, by the L.A. shall be renovated, re-seeded, and maintained meeting all requirements as specified herein.

3. After all necessary corrective work has been completed, the Owner's representative shall certify in writing the final acceptance of the grass area.
4. Decision of Owner as to the necessity to replace grass areas or repair any defects on workmanship, or cause of any destruction or loss, impairment or failure to flourish, shall be conclusive and binding upon Contractor. Replacements shall be the same as specified. All replacements shall be planted as specified herein at Contractor's expense.
5. "Vandalism", as noted above, is intended to mean any acts, whether intentional or accidental, by other persons, which clearly result in damage, and which may reasonably be considered to be beyond the Contractor's reasonable control, as determined by the Owner's representative.

3.4 MAINTENANCE FOR GENERAL LAWN AREAS

A. Maintain grassed areas up to provisional acceptance and a minimum of one full growing season after provisional acceptance to establish an acceptable lawn. For areas seeded in fall, continue maintenance following spring until acceptable lawn is established.

B. Maintain grassed areas by watering, fertilizing, weeding, and trimming.

C. Repair areas damaged by erosion by regrading, rolling and replanting.

D. Reseed small, sparse grass areas. When sparse areas exceed 20 percent of planted area, reseed by hydro mulch.

3.5 ACCEPTANCE OF SEEDING FOR ATHLETIC FIELDS

A. PROVISIONAL ACCEPTANCE

Provisional acceptance period shall be defined as the elapsed time between application of seed and the establishment of a good, healthy uniform growth of grass. Provisional acceptance will only be granted after two full growing season as indicated in Section 1.5

1. Provisional acceptance will not occur until the seeded areas are well established, exhibiting a vigorous growing condition, devoid of bare spots greater than 1 square foot.
3. It will be the contractor’s responsibility to maintain seeding areas in an approved condition until provisional acceptance.
3. The Contractor shall keep all seeded areas watered and in good condition, reseeding if and when necessary during the provisional acceptance period.
4. Watering of seeded areas.
   a. During this period, water grass as necessary to maintain an adequate supply of moisture within the root zone. An adequate supply of moisture is the equivalent of one (1") of absorbed water per week that is delivered at weekly intervals in the form of natural rain or is augmented by periodic watering.
5. It shall be the contractor's responsibility to obtain necessary documentation to show that provisional acceptance has been granted. This shall be done upon written request submitted by the contractor the landscape architect to inspect grass work on site. Provisional acceptance will not be granted until contractor has obtained, in writing, a statement from the landscape architect indicating that grass is satisfactory under the terms of the provisional acceptance.

B. FINAL ACCEPTANCE FOR ATHLETIC FIELDS

Final acceptance period shall be defined as the elapsed time between provisional acceptance and final closeout of the project.

1. All seeded areas shall be guaranteed by the Contractor for not less than one growing season

from the time of provisional acceptance. Growing season shall be defined as follows:

a) If provisional acceptance is received during April, May, June or July, next growing season shall end on October 15.

b) If provisional acceptance is received during September, October, November or December, next growing season shall end on June 1.

2. At the end of the guarantee period, inspection will be made by the landscape architect upon written request submitted by the Contractor at least ten (10) days before the anticipated date. Grass areas not demonstrating satisfactory stands as outlined above, (except if damaged by vandalism) as determined, by the L.A. shall be renovated, re-seeded, and maintained meeting all requirements as specified herein.

3. After all necessary corrective work has been completed, the Owner's representative shall certify in writing the final acceptance of the grass area.

4. Decision of Owner as to the necessity to replace grass areas or repair any defects on workmanship, or cause of any destruction or loss, impairment or failure to flourish, shall be conclusive and binding upon Contractor. Replacements shall be the same as specified. All replacements shall be planted as specified herein at Contractor's expense.

5. "Vandalism", as noted above, is intended to mean any acts, whether intentional or accidental, by other persons, which clearly result in damage, and which may reasonably be considered to be beyond the Contractor's reasonable control, as determined by the Owner's representative.

3.4 MAINTENANCE FOR ATHLETIC FIELDS

A. Maintain grassed areas up to provisional acceptance and a minimum of one full growing season after provisional acceptance to establish an acceptable lawn. For areas seeded in fall, continue maintenance following spring until acceptable lawn is established.

B. Maintain grassed areas by watering, fertilizing, weeding, and trimming.

C. Repair areas damaged by erosion by regrading, rolling and replanting.

D. Reseed small, sparse grass areas. When sparse areas exceed 20 percent of planted area, reseed by hydro mulch.

END OF SECTION

Section 32 92 30
SEEDING FOR NON-LAWN AREAS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

A. Provide all materials, equipment, and labor necessary to complete the work as indicated on the drawings or as specified herein.

B. The principal work of this section includes, but may not be limited to the following:
1. Application of seed.
2. Acceptance of seeding.

C. Related Sections
1. Section 32 92 00, Soil Preparation for Lawn Establishment
2. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
3. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
4. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

D. In general, seeded areas shall, at a minimum, include roadsides, yards and setbacks, meadows, marginal wetlands, and all other areas of site within project limit lines that have been disturbed or are barren unless otherwise noted on the plans. Overseeding of established lawn areas, if required on plans, shall also extend to project limit lines, unless otherwise noted.

1.3 RESTRICTIONS:

A. Prior to seeding, contractor shall clearly and plainly mark his limits as indicated on plans.

B. No work shall be performed prior to field determination and approval from owners' representative.

1.4 QUALITY ASSURANCE

A. Use a contractor who is fully experienced and qualified in such work.

B. Each seed bag or container shall display a label which identifies the contents as a true representation of the seed mix and percentages required by specification. No seed shall be applied to a site until the Owner or Owner's Representative has determined the mixture meets all requirements.

C. Do not make substitutions without written approval. If specified seed mixes are not available, obtain approval for substitution from the Owner or Owner's Representative.

1.5 SUBMITTALS

A. Certifications and/or labels of proposed seed mixtures stating common and scientific names of grasses, percentages by weight, and percentages of purity and germination.

B. Product information of all proposed weed control chemicals.

C. Sustainable Design Submittals:

1. Recycled content: Provide manufacturer's written certification of recycled content as defined in accordance with International Standard ISO 14021–1999, Environmental Labels and Declarations—Self-Declared Environmental Claims (Type II Environmental Labeling). Indicate post-consumer and pre-consumer recycled content and provide documentation certifying products are from recycled sources. (LEED Credit MRc4).

2. Local/regional materials (LEED Credit MRc5):

a. Indicate location of content of extraction, harvesting, and recovery; indicate the distance between extraction, harvesting, and recovery and the project site. Indicate percentage of product content from qualified locations.

b. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.

3. Adhesives and Sealants: Include certification of data indicating Volatile Organic Compound (VOC) content of all field-applied adhesives and sealants and compliance with California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda. Submit MSDS highlighting VOC limits. (LEED Credit IEQc4.1).

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect all products from weather or other damaging or deteriorating conditions.

B. Seed mixes which have been damaged or have deteriorated in transit or storage are not acceptable.

C. Seeding Schedule: Prepare a proposed seeding schedule. Schedule dates for each type of landscape work during normal seasons for such work.

Seeding: March 15 - June 30
August 15 - October 15

D. Correlate with specified maintenance periods to provide maintenance to date of acceptance. Once the schedule is accepted, dates shall be revised and submitted in writing for reasons of delay.

1.7 WARRANTY

A. Warranty seeding until final acceptance of grass stand.

1.8 MAINTENANCE

A. Maintenance of seeding to be performed by the installer includes:
   1. Watering;
   2. Regrading and replanting eroded areas; and
   3. Seeding or patching sparse or bare areas.

B. Maintain seeded areas immediately after placement until grass is accepted.

PART 2 – PRODUCTS

2.1 SEED

A. General: Pure, live, fresh seed from commercial sources, meeting and labeled in accordance with State and Federal laws, rules, and regulations. All seed to have minimum germination rate of 85% unless otherwise noted.

B. Rain Garden Seed Mix shall be "New England Conservation / Wildlife Mix" as supplied by New England Wetland Plants, Inc. or approved equivalent. Percentages of species shall be per New England Wetland Plants specifications.

Seed Botanical Type

Elymus virginicus
Schizachyrium scoparium
Andropogon gerardii
Festuca rubra
Panicum virgatum
Chamaecrista fasciculata
Panicum clandestinum
Sorghastrum nutans
Asclepias syriaca
Heliopsis helianthoides
Eupatorium purpureum
Euthamia graminifolia
Verbena hastate
Zizia aurea
Aster umbellatus
Solidago juncea

Seeding Rate: 25lbs/acre

2.2 COVER CROP SEEDING

A. Cover crop seeding shall be applied to all areas designated as Rain Garden Seed Mix as shown on the Plans.
B. Cover Crop Seed Mix shall be Grain Rye.
C. Grain Rye Cover Crop shall be applied at 30 lbs./acre.

2.3 WATER

A. Potable water to establish and maintain a healthy stand of grass, see section 3.5A.

PART 3 – EXECUTION

3.1 GENERAL

A. Seeded areas shall, at a minimum, include roadsides, yards and setbacks, meadows, marginal wetlands and all other areas of site within project limit lines that have been disturbed or are barren unless otherwise noted on the plans.

3.2 APPLICATION OF SEED

A. The approved seed mixture shall be applied at a rate specified by each particular type of seeding, by means of seeder device capable of penetrating ground to depth of one inch (1"). Seeder machine shall be equipped with disc-type penetrating action and seeder tubes which plant seeds. Seeder machine shall be approved for use by Owner or Owner's Representative prior to seeding.

B. Distribute seed over area in two separate passes, each one perpendicular to the other (north-south, east-west orientation). Each pass shall be in a linear progression, and shall conform to the field direction that permits the longest straight line application procedure.

C. Hydro seeding will be permitted only with permission of Owner or Owner's Representative. All requests shall be in writing with detailed and itemized procedure to be followed.

D. Broadcast seeding will be permitted only with permission of Owner or Owner's Representative. All requests shall be in writing with detailed and itemized procedure to be followed.

3.3 CARE OF SEEDED AREAS

A. Watering: Contractor shall water all seeded areas within 72 hours of seeding operation. One additional watering may be required and will be at discretion of owner.

B. Mowing.
   1. Rain Garden Seed Mixes shall be mowed using a weed-eater to a height of 8" whenever height reaches 18". Trimming lower than 4" will kill many species in the mixes. Problem weeds such as thistle and burdock should be spot treated or hand-pulled each year, including the establishment year. Following the first growing season the site can be mown close to 4 inches height each Spring prior to onset of new growth.

C. Each cutting shall result in a stand of evenly mowed grass, three inches (3") tall immediately following the cutting. Neat trimming shall be necessary around all poles, trees, ledges, delineators, cubs, piers, abutments and other structures falling within the seeded areas; this trimming will be conducted simultaneously with the mowing during each cutting operation. All curbs shall be trimmed and exposed; all gutters will be left free of all grass clippings.

3.4 ACCEPTANCE OF SEEDING

A. PROVISIONAL ACCEPTANCE

Provisional acceptance period shall be defined as the elapsed time between application of seed and the establishment of a good, healthy, uniform growth of grass.

1. Provisional acceptance will not occur until the seeded areas are well established; exhibiting a vigorous growing condition, devoid of bare spots greater than one (1) square foot.
2. It will be the contractor's responsibility to maintain seeding areas in an approved condition until provisional acceptance.
3. The Contractor shall keep all seeded areas watered and in good condition, reseeding if and when necessary during the provisional acceptance period.
4. Watering of seeded areas:
   a) During this period, water grass as necessary to maintain an adequate supply of moisture within the root zone. An adequate supply of moisture is the equivalent of one inch (1") of absorbed water per week that is delivered at weekly intervals in the form of natural rain or is augmented by periodic watering.
5. It shall be the contractor's responsibility to obtain necessary documentation to show that provisional acceptance has been granted. This shall be done upon written request submitted by the contractor the landscape architect to inspect grass work on site. Provisional acceptance will not be granted until contractor has obtained, in writing, a statement from the landscape architect indicating that grass is satisfactory under the terms of the provisional acceptance.

B. FINAL ACCEPTANCE

Final acceptance period shall be defined as the elapsed time between provisional acceptance and final closeout of the project.

1. All seeded areas shall be guaranteed by the Contractor for not less than one growing season from the time of provisional acceptance. Growing season shall be defined as follows:
   a) If provisional acceptance is received during April, May, June or July, next growing season shall end on October 15.
   b) If provisional acceptance is received during September, October, November or December, next growing season shall end on June 1.
2. At the end of the guarantee period, inspection will be made by the Owner upon written request submitted by the Contractor at least ten (10) days before the anticipated date. Grass areas not demonstrating satisfactory stands as outlined above, (except if damaged by vandalism) as determined by the L.A., shall be renovated, re-seeded, and maintained, meeting all requirements as specified herein.
3. After all necessary corrective work has been completed, the Owner's Representative shall certify in writing the final acceptance of the grass area.
4. Decision of Owner as to the necessity to replace grass areas, or repair any defects on workmanship, or cause of any destruction or loss, impairment, or failure to flourish, shall be conclusive and binding upon Contractor. Replacements shall be the same as specified. All replacements shall be planted as specified herein at Contractor's expense.
5. "Vandalism", as noted above, is intended to mean any acts, whether intentional or accidental, by other persons, which clearly result in damage, and which may reasonably be considered to be beyond the Contractor's reasonable control, as determined by the Owner's Representative.

END OF SECTION

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Section 32 92 40
SYNTHETIC TURF SYSTEM: MULTI-USE STADIUM (FIELD A)

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification section, apply to work of this section.

B. Related Sections: The following Sections contain requirements that relate to this Section:
1. Section 03 00 00 – Cast-In-Place Concrete
2. Section 31 00 00 - Earthwork
3. Section 32 13 13 – Site Concrete
4. Section 33 40 00 – Drainage
5. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
6. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
7. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

1.2 DESCRIPTION OF WORK

A. Provide equipment and materials, and do work necessary to construct the filled synthetic turf field surfacing, with permeable base, drainage, field markings. Work shall include but shall not be limited to:
1. Subgrade preparation, crushed stone base, finishing stone, geotextile fabric and required drainage.
2. Synthetic turf surface, infill, field marking, graphics and related finish work.
3. **Contractor shall note that items listed above make up Alternate # 1 for Main Stadium.**

1.3 MINIMUM REQUIREMENTS

A. The successful bidder shall meet the following minimum requirements in order to be considered for installation of the synthetic turf system. **All requirements listed in 1.3 MINIMUM REQUIREMENTS shall be documented and submitted to the Architect for approval prior to commencement of any synthetic turf related work.**
1. Selected Turf Installer must have installed fields greater than three (3) years old of similar materials and design. **Documentation of this shall be furnished per 1.3, A. above.**
2. Turf Installer must install turf using his/her own crews, subcontracting of installation work will not be allowed. **Documentation of this shall be furnished per 1.3, A. above.**
3. Turf Installer must have a minimum of ten (10) outdoor fields at over 50,000 square feet EACH installed in the Northeast United States of similar style and construction. Indoor fields or fields out of this geographic area will not be considered. **A list of these installations with owner's name and phone number shall be furnished per 1.3, A. above.**
4. The synthetic turf surfacing work shall be performed by a Turf Installer having at least five (5) years experience in the installation of materials specified herein on

projects comparable to this Project. The installation crew shall have installed at least five (5) similar installations. The crew foreman shall have installed at least five (5) similar installations**. A list of previous projects installed by crew and foreman shall be furnished per 1.3, A. above.**

5. The Manufacturer of synthetic turf surfacing shall provide evidence indicating that the specified materials have been successfully utilized on work of similar scope **and designed system** to that shown and specified for this Project. The synthetic turf surfacing system examples cited shall have been completed and in use for two (2) years without evidence of failure. **Documentation of this shall be furnished per 1.3, A. above.**
6. The Turf Installer shall have the written approval of the synthetic turf surfacing materials Manufacturer indicating that the Installer is certified to install Manufacturers product. **Documentation of this shall be furnished per 1.3, A. above.**
7. **A sample insurance policy must be shown at time of bid that meets 1.8, A, 7 in this specification.**

1.4 SPECIAL REQUIREMENTS

A. The following special requirements shall apply to this project:

1. An infill mixture of cryogenically processed rubber granules and silica sand. Refer to 2.6 C of this specification for details.
2. Field markings listed in Section 2.8, E of this specification shall be painted by the synthetic turf manufacturer for a minimum of 2 years 2 times a year. Other field markings listed under 2.8 shall be tufted or inlaid.
3. The subgrade, stone base course and finishing stone course shall be surveyed by a Registered Land Surveyor by means of a laser level with a minimum 200 shots per field.
4. G-Max rating shall be of 80-110 range at installation. G-Max rating shall fall within 110-165 range throughout the 8 year warrantee period. The Turf Manufacturer shall remedy any deficiencies during the warranty period.
5. Turf Installer shall supply 500 lbs of specified silica sand and 250 lbs of specified rubber granules in unopened 50 lb or less bags to the Owner upon completion of the project.
6. Turf Installer shall supply 15 foot x 65 foot roll of synthetic turf to the Owner upon completion of the project.
7. Any useable scraps shall become the property of the Owner.
8. Turf Installer shall supply the Manufacturer's recommended groomer and sweeper to the Owner upon completion of the project.
9. **The Installer/Manufacturer shall provide the Owner with a complete maintenance manual for maintaining the synthetic turf systems as well as train the Owner's staff the proper maintenance practices.**

1.5 REFERENCES

A. Comply with applicable requirements of the following standards. Where these standards conflict with other requirements listed in this Specification, the most restrictive requirement shall govern.

1. American Society for Testing and Materials (ASTM):

D 1557	Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu.ft (2,700 KN-m/cu.m.))
F 355	Shock Absorbing Properties of Playing Surface Systems and Materials.

F 355-09 Standard Test Method for Impact Attenuation of Playing Surface Systems and Materials

F 1936-07e1 Standard Specification for Shock-Absorbing Properties of North American Football Field Playing Systems as Measured in the Field

1.6 SUBMITTALS

A. Submit shop drawings and product data to Owner's Representative for approval under provisions of Division 1.
   1. Shop drawings of synthetic turf sports field indicating dimensions and layout of field construction including lining and colors, logo, team name and location and details of crushed stone base, finishing stone and geotextile shall be submitted.

B. Samples
   1. Samples: Submit three (3) samples of the assembled synthetic turf system in a 12 in. x 12 in tray. Each of the three samples shall include the sand and rubber infill, the turf and backing with drainage capabilities fully assembles as they would appear in the final installation. Three one-gallon containers of the crushed stone base and finishing stone shall be submitted separately.

C. Manufacturer's Review
   1. Submit written statement, signed by the Turf Installer and the Turf Manufacturer stating that the Drawings and Specifications have been reviewed by qualified representatives of the Turf Manufacturer, and that they are in agreement that the materials and system, including drainage, to be used for synthetic field surfacing are proper and adequate for the applications shown.

   2. The Turf Manufacturer shall submit at the pre-construction conference a certificate stating that it is not aware of any aspects of the proposed turf system to be installed which knowingly violate any patented materials or methods and that the manufacturer fully indemnifies the Town and Owners' Representative from any liability arising out of any issue related to patent infringement.

D. Manufacturer's Data
   1. Submit Manufacturer's specifications and installation instructions for all products in the synthetic turf surfacing system, including certifications and other data as may be required to show compliance with the Contract Documents.

E. Sustainable Design Submittals:

   1. Recycled content: Provide manufacturer's written certification of recycled content as defined in accordance with International Standard ISO 14021–1999, Environmental Labels and Declarations—Self-Declared Environmental Claims (Type II Environmental Labeling). Indicate post-consumer and pre-consumer recycled content and provide documentation certifying products are from recycled sources. (LEED Credit MRc4).

   2. Local/regional materials (LEED Credit MRc5):

      a. Indicate location of content of extraction, harvesting, and recovery; indicate the distance between extraction, harvesting, and recovery and the project site. Indicate percentage of product content from qualified locations.

b. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.

3. Adhesives and Sealants: Include certification of data indicating Volatile Organic Compound (VOC) content of all field-applied adhesives and sealants and compliance with California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda. Submit MSDS highlighting VOC limits. (LEED Credit IEQc4.1).

1.7 QUALITY ASSURANCE

A. The approved Installer and Manufacturer of the synthetic turf system shall meet with the Site Contractor and General Contractor to review the following:

1. Review entire system including subgrade, stone base, finishing stone, edge conditions, grading, irrigation, utilities and drainage items to ensure all components are complimentary for a successful system.
2. Review and coordinate lead time manufactured items, base preparation time and approvals for grading, surveying and inspection time.

B. Crushed stone base work shall be done only after excavation and construction work which might damage it has been competed. Damage caused during construction shall be repaired before acceptance.

C. Contractor shall provide test results from certified laboratory certifying capability of stone base course to meet permeability and stability requirements before construction. Testing laboratory qualifications shall be submitted to the Architect for approval.

D. Turf Manufacturer shall provide written approval to the Owner’s Representative that the Manufacturer is satisfied with the crushed stone base and the finishing stone test analysis to ensure migration of stone is limited.

E. Lay test strip and establish compaction and density rates for each course with nuclear gauge before beginning permanent work.

F. Installation of synthetic turf surfacing shall be done only after excavation and construction work which might injure it has been completed. Damage caused during construction shall be repaired before acceptance.

G. The Turf Installer shall coordinate with other subcontractors to ensure that the installation of the synthetic turf surface and the surrounding surfaces have an optimum interface at all edges at no cost to the Town. This includes but is not limited to confirming that the surrounding track base is graded properly with no failures prior to installing synthetic turf.

1.8 GUARANTEE

A Warranties: The Contractor shall provide a warranty to the Owner that covers defects in materials and workmanship of the turf for a period of eight (8) years from the date of substantial completion. The turf manufacturer must verify that their representative has inspected the installation and that the work conforms to the manufacturer's requirements. The manufacturer's warranty shall include general wear and damage caused from UV degradation. The warranty shall specifically exclude vandalism, and acts of God beyond the control of the Owner or the manufacturer. The warranty shall be fully third party insured, pre paid for the entire 8 year term and be non-prorated. The Contractor shall provide a warranty to the Owner that covers defects in the installation workmanship, and

further warrant that the installation was done in accordance with both the manufacturer's recommendations and any written directives of the manufacturer's representative. Prior to final payment for the synthetic turf, the Contractor shall submit to Owner notification in writing that the field is officially added to the annual policy coverage, guaranteeing the warranty to the Owner.

The insurance policy must be underwritten by a minimum A.M. Best A- carrier and must reflect the following values:

1. Maximum of one million dollar ($1,000,000) per claim coverage amount.
2. Minimum of five million dollar ($5,0000,000) annual aggregate.
3. Must cover full 100% replacement value of total square footage installed, minimum of $7.00 per sq ft. (in case of complete product failure, which will include removal and disposal of the existing surface)
4. Pre Paid 8 year third party policy must be issued by a carrier with an A.M. Best rated "A-" or better rating.
5. Policies that include self insurance or self retention clauses shall not be considered.
6. Policy cannot include any form of deductible amount.
7. Sample policy must be shown at time of bid to prove that policy is in force. A letter from an agent or a sample Certificate of Insurance will not be acceptable.

1.9 FOLLOW-UP VISITS

A. The Turf Manufacturer shall include two (2) follow-up visits at six (6) month intervals after the Final Inspection date. The visits shall be scheduled with the Town or Town's representative to inspect the condition of the synthetic turf, infill material, seams, painted lines, anchorage, and peripheral attachments. Items found to require repair, amendment, or replacement shall be the responsibility of the Turf Manufacturer. Repairs, except those required due to vandalism, shall take place within 48 hours.

B. The Turf Manufacturer shall perform G-Max testing after one months' use of the field and at each of the six (6) month follow-up visits described in 1.9 A. The Turf Manufacturer shall remedy any deficiencies.

PART 2 – PRODUCTS

2.1 SYNTHETIC TURF CAST-IN-PLACE CONCRETE ANCHOR CURB

A. Concrete shall comply with 32 13 13 - Site Concrete and 03 30 00 – Cast-In-Place Concrete.

B. The cast-in-place concrete anchor curb for the synthetic turf field shall be in accordance with details provided in the construction documents.

1. The anchor curb shall be formed by hand.
2. The anchor curb shall be in strict accordance with the grading plan and shall be inspected and approved by the Turf Installer. Repairs shall be made to the satisfaction of the Turf Installer at no additional cost to the Town.

C. Drain system shall be installed as per the contract documents and any modifications from the Turf Manufacturer based on comments from Section1.6 C of this specification.

2.2 REQUIREMENTS OF THE SUBGRADE

A. A soil test is required on the intended surface to be covered by the synthetic turf. These tests shall provide the following information:

1. Permeability and/or hydraulic conductivity
2. Percolation rate

3. Moisture content at the time of the test
4. Sieve analysis and plasticity limits determination test
5. Depth to the water table
6. In situ compaction, estimated or measured
7. Any external features that could affect the drainage characteristics of the field.
8. Surrounding slopes and conditions that could bring additional water to the field in question.
9. Pictures or video of the site on DVD.

2.3 GEOTEXTILE FABRIC

A. Geotextile fabric shall be Geotextile 1 conforming to the specification in Section 31 00 00 – Earthwork, 2.8, A.

2.4 CRUSHED STONE BASE

A. Crushed stone base shall be a graded, granular, non-frost susceptible, free-drainage material, consisting of either durable stone and coarse sand or of blast furnace slag, stone, and gravel blends practically free from loam and clay, and which can be readily compacted to form a stable, permeable, foundation, graded as follows:

Sieve Size	% Passing by Weight
1 in.	100
3/4 in.	85-100
3/8 in.	50-80
No. 4	35-60
No. 10	25-50
No. 40	15-30
No. 200	0-3

B. The specified crushed stone base supplied shall conform to the Turf Manufacturer's recommended specifications.

C. The crushed stone base supplied shall be stable and sufficiently permeable to ensure all-weather availability of the field.

2.5 FINISHING STONE

A. The finishing stone shall be clean, free-drainage material free from loam and clay and which can be readily compacted to form a stable, permeable base and shall meet the following gradation requirements:

Sieve Size	% Passing by Weight
1/2"	100
3/8"	85-100
No. 8	35-75
No. 16	10-55
No. 30	0-40
No. 50/60	0-15
No. 100	0-8
No. 200	0-2

2.6 SYNTHETIC TURF COMPONENTS

A. Carpet Fiber: A synthetic turf carpet consisting of nominal 2½" long low friction blended polyethylene fiber, of monofilament design. **Color shall be green.**
   1. The lead content of the yarn must adhere to the maximum standards and comply with applicable requirements of the following standards. Where these standards

conflict with other requirements in this specification, the most restrictive requirement shall govern.

American Society for Testing and Materials (ASTM):

F2765-09 Standard Specification for Total Lead Content in Synthetic Turf Fibers

2. The carpet fiber shall have the following properties:

ASTM	Property	Specifications
D1577	Denier (min.)	10,000 nominal
D5823	Pile Height (min.)	2 ½" nominal
D5848	Pile Weight (min.)	40 oz./sq. yd.

B. Backing: A minimum of two backings are required:

1. Primary backing shall include a UV-treated woven polypropylene, weighing a minimum of 8 oz./sq.yd.
2. Secondary backing other backing shall be a permeable application of moisture cure urethane to lock the fiber tufts into the backing, weighing a minimum of 22 oz./sq.yd.
3. The fibers will be stitched at a minimum ½" stitch gauge.

C. Infill: A two (2) inch thick infill system consisting of a mixture comprised of selected and graded dust-free silica sand and cryogenically processed rubber granules. The infill is installed so as to leave approximately 1/2" of the tufts clear of the top of the infill.

1. Silica Sand and shall consist of uniform, sub-angular to rounded, single grains. It shall be dust free, and un-ground. Crusher fines are unacceptable. Silica sand within the infill mix shall meet the following size distribution:

U.S. (Mesh)	Metric (mm)	% Retained per sieve
16	1.190	0
20	0.840	0-3
25	0.710	10-30
30	0.590	30-50
35	0.500	15-35
40	0.420	5-15
50	0.297	<5
70	0.210	Trace

2. Crumb Rubber Infill shall be processed rubber granules within the infill mix shall be derived from used whole vulcanized automobile, SUV, and truck tires (DOT tires for over the road). Buffings, bladders, and tubes are not allowed. Crumb rubber infill shall have a specific gravity range from 1.1 minimum to 1.2 maximum grams per cubic centimeters as determined by ASTM D 297. Crumb rubber infill shall have an ash content between 5 percent and 15 percent as determined by ASTM D297. Crumb rubber infill shall not contain not more than .01 percent liberated fiber tested per ASTM D 5603. The liberated fiber remaining in the crumb rubber infill shall be free flowing and not agglomerated into clumps of fiber. Crumb rubber infill shall have the following size distribution:

U.S. (Mesh)	Metric (mm)	% Passing	% Retained

12	1.680	100	0
14	1.410	96-100	0-5
16	1.190	82-100	0-15
20	0.840	30-66	30-80
30	0.590	0-24	20-50
40	0.420	0-4	5-20
50	0.297	0	0-5
60	0.250		0

3. The mixture shall be a maximum of 50% silica sand and minimum of 50% cryogenically processed rubber granules OR a minimum of 30% silica sand and maximum of 70% cryogenically processed rubber granules. Mix shall be by weight and homogeneously mixed.
4. Sand and rubber mixture shall meet the specified design criteria for the specified G-max rating for the full warrantee period.

2.7 FIELD MARKING

A. All field marking lines shall be four (4) inch in width with the exception of team names and logos.

B. All markings listed below shall be confirmed in writing with the Owner prior to manufacturing of the synthetic turf.

C. The following items shall be tufted into the carpet with the designated color:
1. Football - end zones, sidelines and 5 yard lines - White
2. Soccer - sidelines and endlines - Yellow

D. The following items shall be inlaid into the synthetic turf with the designated color.
3. Girls lacrosse - goal circle, 8 meter fan – Red
4. School Logo – Design and color to be provided by the Owner.

E. The following items shall be painted onto the synthetic turf with the designated color. Marking Paint: Only paint approved by the Manufacturer is permitted to be used on the turf.
1. Football - all hash marks, yard line numbers, directional arrows - White
2. Soccer - center circle, goalie box, penalty box, corner kick arc - Yellow
3. Boys lacrosse – sidelines, endlines, face off lines, penalty box, and goal circle – Blue
4. Girls lacrosse – sideslines, endlines, goal circle, 8 meter fan,12 meter fans - Red

2.8 MAINTENANCE EQUIPMENT

A. The Turf Installer shall provide the Owner with a **hydraulic** sweeper and a **hydraulic** groomer to maintain the synthetic turf field. Instructions and manuals shall accompany the equipment.

PART 3 - EXECUTION

3.1 SYSTEM CHARACTERISTICS

A. Permeability (to ASTM D 4491): The system, turf and base, shall allow a minimum percolation rate of 16 inches per hour.

B. Relative Abrasiveness (to ASTM F 1015): The system has an Abrasiveness Index of 20.2.

C. Shock Absorbency (to ASTM F 355): Immediately upon substantial completion, the Turf Installer shall arrange for shock absorbency testing by a certified laboratory subject to approval by the Town's Representative in accordance with ASTM F 355-Method A. Testing will be performed at a minimum of ten locations selected by the Town's Representative. The average G-max value at installation shall be between 80 and 110. The Turf Installer, prior to acceptance, shall remedy an average G-max value outside this range, or individual reading more than 10% outside this range. Satisfactory G-max testing shall be a fixed requirement for final payment of the synthetic turf installation and release of retainage.

3.2 SUBGRADE PREPARATION

A. All topsoil, organic, and non-compactable materials shall be stripped, screened, stockpiled locally, and protected. Existing subgrade material which will not readily compact shall be removed and replaced with satisfactory materials. Additional materials needed to bring subgrade to required line and grade and to replace unsuitable material removed shall be material conforming to this Section.

B. Subgrade of areas to be surfaced with synthetic turf shall be re-compacted to bring top 9 inches of material immediately below stone base course to a compaction rate of 95% Standard Proctor in both directions. Subgrade compaction shall extend for a distance of a least one (1) foot beyond turf edge, if not so supported.

C The subgrade shall have a minimum slope of 0.5% or more depending on the soil analysis from the longitudinal center of the field towards the sidelines.

D. The subgrade surface shall not vary from the specified grade by more than ¼" in 10 feet when measured in any direction and shall allow for even drainage.

E. Excavation required in subgrade shall be completed before fine grading and final compaction of subgrade are performed. Where excavation must be performed in completed subgrade, subsequent backfill and compaction shall be performed as specified. Completed subgrade after filling such areas shall be uniformly and properly graded.

F. Areas being graded or compacted shall be kept shaped and drained during construction. Ruts greater than or equal to two (2) inches deep in subgrade, shall be graded out, reshaped, and re-compacted before placing stone base course.

G. Materials shall not be stored or stockpiled on subgrade.

H. Disposal of debris and other material excavated and/or stripped under this section, and material unsuitable for or in excess of requirements for completing work of this Section shall conform to the following:
   1. Material shall be legally disposed of off-site.

I. Laser grading of the subgrade shall be completed per 1.4 A- 3 of this Specification.

J. Prepared subgrade shall be inspected by the Turf Manufacturer's representative. The Turf Installer shall not proceed with installation of stone base course without written approval of the Owner's Representative. Disturbance to subgrade caused by inspection procedures shall be repaired under this Section of the specification.

K. Geotextile fabric shall be laid according to turf Manufacturer's recommendations, specification Section 31 00 00 – Earthwork and as shown on the plans.

3.3 STONE BASE COURSE

A. Stone base course for surfacing and the spreading, grading, and compaction methods employed shall conform to standard requirements for usual base course of this type for first class road work, and the following:
   1. Massachusetts Highway Department Standard Specifications for Highways and Bridges, Latest Edition.

B. The crushed stone shall be laid without damaging the subgrade. The Installer shall also ensure that the crushed stone base and drainage structures are not damaged by heavy equipment.

C. The stone base shall be constructed in layers or lifts less than or equal to the depths indicated on the plans and of approximate equal thickness each,, compacted measure. Each layer shall be separately compacted to a compaction rate of 95% Standard Proctor in both directions.

D. The stone base shall have a minimum slope of 0.5% from the center longitudinal center of the field towards the sidelines.

E. The stone base surface shall not vary from the specified grade by more than ¼" in 10 feet when measured in any direction. Stones greater than one (1) inch shall be excluded from course.

F. Width of stone base course shall be greater than or equal to the width of turf surface, if continuous lateral support is provided during rolling, and shall extend at least two (2) x base thickness beyond edge of the course above, if not so supported.

G. Stone base shall be applied in lifts less than or equal to the depths indicated on the plans, compacted measure. Each lift shall be separately compacted to specified density listed in 3.3 C of this specification.
   1. Material shall be placed adjacent to structures only after they have been set to required grade and level.

   2. Surface irregularities which exceed 1/4 inch measured by means of a 10 ft. long straightedge shall be replaced and properly compacted.

H. Subgrade and stone base course shall be kept clean and uncontaminated. Less select materials shall not be permitted to become mixed with gravel. Materials spilled shall not be permitted to become mixed with gravel. Materials spilled outside specified lines shall be removed and areas repaired.

I. Portions of subgrade or of construction above which become contaminated, softened, or dislodged by passing of traffic, or otherwise damaged, shall be cleaned, replaced, and otherwise repaired to conform to the requirements of this specification before proceeding with next operation.

J. Laser grading of the stone base course shall be completed per 1.4 A- 3 of this Specification.

K. Prepared stone base course shall be inspected by the Turf Manufacturer's representative. The Turf Installer shall not proceed with installation of the finished stone without written approval of the Owner's Representative. Disturbance to stone base caused by inspection procedures shall be repaired under this Section of the specification.

L. The Turf Installer shall verify that the subsurface drainage system is functioning properly prior to the commencement of the Infilled Synthetic Turf System installation by thoroughly flooding the field area and verifying and recording flow from the drainage system outlet. Documentation shall be submitted to the Owner's Representative for approval.

M. The Turf Installer shall verify that the surrounding track base is draining properly prior to commencement of the infilled synthetic turf system.

3.4 FINISHING STONE

A. The final grade of the finishing stone shall be two (2) inches thick.

B. The final grade shall be compacted to a compaction rate of 95% Standard Proctor in both directions.

C. The final grade material must be sloped 0.5% from the center longitudinal axis towards the side lines unless otherwise specified.

D. Laser grading of the stone base course shall be completed per 1.4 A- 3 of this Specification.

E. Prepared finishing stone shall be inspected by the Turf Manufacturer's representative. The Turf Installer shall not proceed with installation of the synthetic turf without written approval of the Owner's Representative. Disturbance to the finishing stone caused by inspection procedures shall be repaired under this Section of the specification.

3.5 SYNTHETIC FIELD SURFACING

A. The tufts shall be unfolded prior to installation.

B. All turf seams shall be sewn with a double-locked stitch. Seams shall be combed to ensure that threads are not exposed, but are hidden within the nap.

C. Glued seams will not be permitted.

D. Excess material beyond stitch shall be removed to ensure a level playing surface.

3.6 SYNTHETIC FIELD SURFACING

A. Prior to the installation of turf, the Turf Installer shall have surveyed the area to be covered and the longitudinal and lateral center lines and perimeter edge lines shall be located, marked, and staked five (5) feet outside of the actual limits of the turf surface OR the outside of the track.

B. After acceptance of the constructed base, the carpet shall be laid out on the site and consecutive panels shall be sewn together at the seams.

C. The infill, of cryogenically processed rubber granules and selected graded silica sand, shall be approved by the Manufacturer, and will be inserted according to the Manufacturer's approved procedures.
   1. The bristles of any brooms used, either during the original installation, or in subsequent maintenance, shall be of nylon only, shall under no circumstances include any metal.

D. Field Markings
   1. See Section 2.8 of this specification for information.

E. Installation Limitations
   1. Installation shall not proceed when:
      a. Ambient air temperature is below 40 degrees F.
      b. Material temperature is below 40 degrees F.
      c. Rain is falling or pending, unless acceptable to qualified installers.
      d. Conditions exist, or are pending, that will be unsuitable for the installation of the system.

3.7 PROTECTION

A. The Turf Installer shall advise the Site Contractor and /or General Contractor of procedures required for protection and maintenance of finished synthetic field surfacing during remainder of construction period so that surfacing will be undamaged at time of acceptance.

B. Upon completion of the synthetic field surface, the General Contractor shall be responsible for protection of the field surface for the remainder of the Contract.

END OF SECTION

Section 32 92 41
SYNTHETIC TURF SYSTEM: BALL FIELDS (FIELD B AND C)

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification section, apply to work of this section.

B. Related Sections: The following Sections contain requirements that relate to this Section:
1. Section 03 00 00 – Cast-In-Place Concrete
2. Section 31 00 00 - Earthwork
3. Section 33 40 00 – Drainage
4. Section 11 68 00 - Playfield Equipment and Structures
4. Section 32 31 14 – Black Vinyl Chain Link Fencing
6. Section 32 18 17 – Special Surfaces
5. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
6. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
7. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

1.2 DESCRIPTION OF WORK

A. Provide equipment and materials, and do work necessary to construct the filled synthetic turf field surfacing, with permeable base, drainage, field markings. Work shall include but shall not be limited to:

B. Subgrade preparation, crushed stone base, finishing stone, geotextile fabric and required drainage
.

C. Synthetic turf surface, infill, field marking, and related finish work.

D. Maintenance equipment.

E. **Contractor shall note that items listed above, including bituminous paving base and top course make up Alternate # 3.**

1.3 MINIMUM REQUIREMENTS

A. The successful bidder shall meet the following minimum requirements in order to be considered for installation of the synthetic turf system. **All requirements listed in 1.3 MINIMUM REQUIREMENTS shall be documented and submitted to the Architect for approval prior to commencement of any synthetic turf related work.**
1. Selected Turf Installer must have installed fields greater than three (3) years old of similar materials and design. **Documentation of this shall be furnished per 1.3, A. above.**

2. Turf Installer must install turf using his/her own crews, subcontracting of installation work will not be allowed. **Documentation of this shall be furnished per 1.3, A. above.**
3. Turf Installer must have a minimum of ten (10) outdoor fields at over 50,000 square feet EACH installed in the Northeast United States of similar style and construction. Indoor fields or fields out of this geographic area will not be considered. **A list of these installations with owner's name and phone number shall be furnished per 1.3, A. above.**
4. The synthetic turf surfacing work shall be performed by a Turf Installer having at least five (5) years experience in the installation of materials specified herein on projects comparable to this Project. The installation crew shall have installed at least five (5) similar installations. The crew foreman shall have installed at least five (5) similar installations**. A list of previous projects installed by crew and foreman shall be furnished per 1.3, A. above.**
5. The Manufacturer of synthetic turf surfacing shall provide evidence indicating that the specified materials have been successfully utilized on work of similar scope and designed system to that shown and specified for this Project. The synthetic turf surfacing system examples cited shall have been completed and in use for two (2) years without evidence of failure. **Documentation of this shall be furnished per 1.3, A. above.**
6. The Turf Installer shall have the written approval of the synthetic turf surfacing materials Manufacturer indicating that the Installer is certified to install Manufacturers product. **Documentation of this shall be furnished per 1.3, A. above.**
7. A sample insurance policy must be shown at time of bid that meets 1.8, A, 7 in this specification.

1.4 SPECIAL REQUIREMENTS

A. The following special requirements shall apply to this project:
1. An infill mixture of cryogenically processed rubber granules and silica sand. Refer to 2.6 C of this specification for details.
2. Field markings listed in Section 2.7, E of this specification shall be painted by the synthetic turf manufacturer for a minimum of two (2) years. Other field markings listed under 2.7 shall be tufted or inlaid.
3. The subgrade, stone base course and finishing stone course shall be surveyed by a Registered Land Surveyor by means of a laser level with a minimum 200 shots per field.
4. G-Max rating shall be of 100-120 range at installation. Allowable G-Max rating shall fall within 120-165 range throughout the 8 year warrantee period. The Turf Manufacturer shall remedy any deficiencies during the warranty period.
5. Turf Manufacturer must warranty the turf with the knowledge that Javelin may be thrown on the turf with plastic tips.
6. Turf Installer shall supply 500 lbs of specified silica sand and 250 lbs of specified rubber granules in unopened 50 lb or less bags to the Owner upon completion of the project.
7. Turf Installer shall supply 15 foot x 65 foot roll of synthetic turf to the Owner upon completion of the project.
8. The Turf Installer shall provide four (4) extra replaceable panels for each of the following: batters box, three slide boxes.
9. Any useable scraps shall become the property of the Owner.
10. Turf Installer shall supply the Manufacturer's recommended groomer and sweeper to the Owner upon completion of the project.

11. The Installer/Manufacturer shall provide the Owner with a complete maintenance manual for maintaining the synthetic turf systems as well as train the Owner's staff the proper maintenance practices.

1.5 REFERENCES

A. Comply with applicable requirements of the following standards. Where these standards conflict with other requirements listed in this Specification, the most restrictive requirement shall govern.
1. American Society for Testing and Materials (ASTM):

D 1557	Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu.ft (2,700 KN-m/cu.m.))
F 355	Shock Absorbing Properties of Playing Surface Systems and Materials.
F 355-09	Standard Test Method for Impact Attenuation of Playing Surface Systems and Materials
F 1936-07e1	Standard Specification for Shock-Absorbing Properties of North American Football Field Playing Systems as Measured in the Field

1.6 SUBMITTALS

A. Submit shop drawings and product data to Owner's Representative for approval under provisions of Division 1.
1. Shop drawings of synthetic turf sports field indicating dimensions and layout of field construction including lining and color and location and details of crushed stone base, finishing stone and geotextile shall be submitted.

B. Samples
1. Samples: Submit three (3) samples of the assembled synthetic turf system in a 12 in. x 12 in tray. Each of the three samples shall include the sand and rubber infill, the turf and backing with drainage capabilities fully assembles as they would appear in the final installation. Three one-gallon containers of the crushed stone base and finishing stone shall be submitted separately.

C. Manufacturer's Review
1. Submit written statement, signed by the Turf Installer and the Turf Manufacturer stating that the Drawings and Specifications have been reviewed by qualified representatives of the Turf Manufacturer, and that they are in agreement that the materials and system, including drainage, to be used for synthetic field surfacing are proper and adequate for the applications shown.

2. The Turf Manufacturer shall submit at the pre-construction conference a certificate stating that it is not aware of any aspects of the proposed turf system to be installed which knowingly violate any patented materials or methods and that the manufacturer fully indemnifies the Town and Owners' Representative from any liability arising out of any issue related to patent infringement.

D. Manufacturer's Data

1. Submit Manufacturer's specifications and installation instructions for all products in the synthetic turf surfacing system, including certifications and other data as may be required to show compliance with the Contract Documents.

E. Sustainable Design Submittals:

1. Recycled content: Provide manufacturer's written certification of recycled content as defined in accordance with International Standard ISO 14021–1999, Environmental Labels and Declarations—Self-Declared Environmental Claims (Type II Environmental Labeling). Indicate post-consumer and pre-consumer recycled content and provide documentation certifying products are from recycled sources. (LEED Credit MRc4).

2. Local/regional materials (LEED Credit MRc5):

a. Indicate location of content of extraction, harvesting, and recovery; indicate the distance between extraction, harvesting, and recovery and the project site. Indicate percentage of product content from qualified locations.

b. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.

3. Adhesives and Sealants: Include certification of data indicating Volatile Organic Compound (VOC) content of all field-applied adhesives and sealants and compliance with California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda. Submit MSDS highlighting VOC limits. (LEED Credit IEQc4.1).

1.7 QUALITY ASSURANCE

A. The approved Installer and Manufacturer of the synthetic turf system shall meet with the Site Contractor and General Contractor to review the following:

1. Review entire system including subgrade, stone base, finishing stone, edge conditions, grading, irrigation, utilities and drainage items to ensure all components are complimentary for a successful system.
2. Review and coordinate lead time manufactured items, base preparation time and approvals for grading, surveying and inspection time.

B. Crushed stone base work shall be done only after excavation and construction work which might damage it has been competed. Damage caused during construction shall be repaired before acceptance.

C. Contractor shall provide test results from certified laboratory certifying capability of stone base course to meet permeability and stability requirements before construction. Testing laboratory qualifications shall be submitted to the Architect for approval.

D. Turf Manufacturer shall provide written approval to the Owner's Representative that the Manufacturer is satisfied with the crushed stone base and the finishing stone test analysis to ensure migration of stone is limited.

E. Lay test strip and establish compaction and density rates for each course with nuclear gauge before beginning permanent work.

F. Installation of synthetic turf surfacing shall be done only after excavation and construction work which might injure it has been completed. Damage caused during construction shall be repaired before acceptance.

G. The Turf Installer shall coordinate with other subcontractors to ensure that the installation of the synthetic turf surface and the surrounding surfaces have an optimum interface at all edges at no cost to the Town. This includes but is not limited to confirming that the surrounding track base is graded properly with no failures prior to installing synthetic turf.

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The insurance policy must be underwritten by a minimum A.M. Best A- carrier and must reflect the following values:

1. Maximum of one million dollar ($1,000,000) per claim coverage amount.
2. Minimum of five million dollar ($5,0000,000) annual aggregate.
3. Must cover full 100% replacement value of total square footage installed, minimum of $7.00 per sq ft. (in case of complete product failure, which will include removal and disposal of the existing surface)
4. Pre Paid 8 year third party policy must be issued by a carrier with an A.M. Best rated “A-” or better rating.
5. Policies that include self insurance or self retention clauses shall not be considered.
6. Policy cannot include any form of deductible amount.
7. Sample policy must be shown at time of bid to prove that policy is in force. A letter from an agent or a sample Certificate of Insurance will not be acceptable.

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A. The Turf Manufacturer shall include two (2) follow-up visits at six (6) month intervals after the Final Inspection date. The visits shall be scheduled with the Town or Town’s representative to inspect the condition of the synthetic turf, infill material, seams, painted lines, anchorage, and peripheral attachments. Items found to require repair, amendment, or replacement shall be the responsibility of the Turf Manufacturer. Repairs, except those required due to vandalism, shall take place within 48 hours.

B. The Turf Manufacturer shall perform G-Max testing after one months’ use of the field and at each of the six (6) month follow-up visits described in 1.9 A. The Turf Manufacturer shall remedy any deficiencies.

PART 2 – PRODUCTS

2.1 SYNTHETIC TURF CAST-IN-PLACE CONCRETE ANCHOR CURB

A. Concrete shall comply with 03 30 00 – Cast-In-Place Concrete.

B. The cast-in-place concrete anchor curb for the synthetic turf field shall be in accordance with details provided in the construction documents.
1. The anchor curb shall be formed by hand.
2. The anchor curb shall be in strict accordance with the grading plan and shall be inspected and approved by the Turf Installer. Repairs shall be made to the satisfaction of the Turf Installer at no additional cost to the Town.

C. Drain system shall be installed as per the contract documents and any modifications from the Turf Manufacturer based on comments from Section1.6 C of this specification.

2.2 REQUIREMENTS OF THE SUBGRADE

A. A soil test is required on the intended surface to be covered by the synthetic turf. These tests shall provide the following information:
1. Permeability and/or hydraulic conductivity
2. Percolation rate
3. Moisture content at the time of the test
4. Sieve analysis and plasticity limits determination test
5. Depth to the water table
6. In situ compaction, estimated or measured
7. Any external features that could affect the drainage characteristics of the field.
8. Surrounding slopes and conditions that could bring additional water to the field in question.
9. Pictures or video of the site on DVD.

2.3 GEOTEXTILE FABRIC

A. Geotextile fabric shall be Geotextile 1 conforming to the specification in Section 31 00 00 – Earthwork, 2.8, A.

2.4 CRUSHED STONE BASE

A. Crushed stone base shall be a graded, granular, non-frost susceptible, free-drainage material, consisting of either durable stone and coarse sand or of blast furnace slag, stone, and gravel blends practically free from loam and clay, and which can be readily compacted to form a stable, permeable, foundation, graded as follows:

Sieve Size	% Passing by Weight
1 in.	100
3/4 in.	85-100
3/8 in.	50-80
No. 4	35-60
No. 10	25-50
No. 40	15-30
No. 200	0-3

B. The specified crushed stone base supplied shall conform to the Turf Manufacturer's recommended specifications.

C. The crushed stone base supplied shall be stable and sufficiently permeable to ensure all-weather availability of the field.

2.5 FINISHING STONE

A. The finishing stone shall be clean, free-drainage material free from loam and clay and which can be readily compacted to form a stable, permeable base and shall meet the following gradation requirements:

Sieve Size	% Passing by Weight
1/2"	100
3/8"	85-100
No. 8	35-75
No. 16	10-55
No. 30	0-40
No. 50/60	0-15
No. 100	0-8
No. 200	0-2

2.6 SYNTHETIC TURF COMPONENTS

A. Carpet Fiber: A synthetic turf carpet consisting of nominal 2" long low friction blended polyethylene fiber, of slit film design and monofilament.

1. The lead content of the yarn must adhere to the maximum standards and comply with applicable requirements of the following standards. Where these standards conflict with other requirements in this specification, the most restrictive requirement shall govern.

   American Society for Testing and Materials (ASTM):

   F2765-09 Standard Specification for Total Lead Content in Synthetic Turf Fibers

2. The carpet fiber shall have the following properties:

ASTM	Property	Specifications
D1577	Denier (min.)	10,000 nominal
D5823	Pile Height (min.)	2" nominal
D5848	Pile Weight (min.)	42oz./sq. yd.

3. The carpet colors shall be as follows:
   a. Bases as shown on the plans – Brown or Terra Cotta as shown on the Plans.
   b. Field – Green
   c. Field Markings – per 2.7 of this specification

B. Backing: A minimum of two backings are required:

1. Primary backing shall include a UV-treated woven polypropylene, weighing a minimum of 8 oz./sq.yd.
2. Secondary backing other backing shall be a permeable application of moisture cure urethane to lock the fiber tufts into the backing, weighing a minimum of 22 oz./sq.yd.

3. The fibers will be stitched at a minimum ½" stitch gauge.

C. Infill: A one quarter (1 1/4) inch thick infill system consisting of a mixture comprised of selected and graded dust-free silica sand and cryogenically processed rubber granules. The infill is installed so as to leave approximately 3/4" of the tufts clear of the top of the infill.

1. Silica Sand and shall consist of uniform, sub-angular to rounded, single grains. It shall be dust free, and un-ground. Crusher fines are unacceptable. Silica sand within the infill mix shall meet the following size distribution:

U.S. (Mesh)	Metric (mm)	% Retained per sieve
16	1.190	0
25	0.710	10-30
20	0.840	0-3
30	0.590	30-50
35	0.500	15-35
40	0.420	5-15
50	0.297	<5
70	0.210	Trace

2. Cryogenically processed rubber granules within the infill mix shall meet the following size distribution:

U.S. (Mesh)	Metric (mm)	% Passing	% Retained
12	1.680	100	0
14	1.410	96-100	0-5
16	1.190	82-100	0-15
20	0.840	30-66	30-80
30	0.590	0-24	20-50
40	0.420	0-4	5-20
50	0.297	0	0-5
60	0.250		0

3. The mixture shall be 30% silica sand and 70% cryogenically processed rubber granules for all areas except warning tracks. The mix shall be by weight and homogeneously mixed.

4. Sand and rubber mixture shall meet the specified design criteria for the specified G-max rating for the full warrantee period.

5. The **warning track** areas designated on the plans shall receive a ratio of 50% silica sand and 50% cryogenically processed rubber granules.

2.7 FIELD MARKING

A. All field marking lines shall be four (4) inch in width. Color shall be white.

B. All markings listed below shall be confirmed in writing with the Owner prior to manufacturing of the synthetic turf.

C. The following items shall be tufted into the carpet:
   1. Straight foul lines

D. The following items shall be inlaid into the synthetic turf:
   1. Base lines
   2. Catcher and batters box as a replaceable panel at the circle diameter shown on the plans.
   3. First, second and third base as replaceable panels. Each panel shall include the base area and extend a minimum of eight (8) feet along each base line. The baseline extensions shall be a minimum of three (3) feet wide.

E. The following items shall be painted onto the synthetic turf:
   1. Curved limit of infield line
   2. Coaches boxes
   3. Paint shall be in accordance with the Manufacturer's recommendations.

2.8 MAINTENANCE EQUIPMENT

A. The Turf Installer shall provide the Owner with a hydraulic sweeper and a groomer to maintain the synthetic turf field. Instructions and manuals shall accompany the equipment.

PART 3 - EXECUTION

3.1 SYSTEM CHARACTERISTICS

A. Permeability (to ASTM D 4491): The system, turf and base, shall allow a minimum percolation rate of 16 inches per hour.

B. Relative Abrasiveness (to ASTM F 1015): The system has an Abrasiveness Index of 20.2.

C. Shock Absorbency (to ASTM F 355): Immediately upon substantial completion, the Turf Installer shall arrange for shock absorbency testing by a certified laboratory subject to approval by the Town's Representative in accordance with ASTM F 355-Method A. Testing will be performed at a minimum of ten locations selected by the Town's Representative. The average G-max value at installation shall be between 80 and 110. The Turf Installer, prior to acceptance, shall remedy an average G-max value outside this range, or individual reading more than 10% outside this range. Satisfactory G-max testing shall be a fixed requirement for final payment of the synthetic turf installation and release of retainage.

3.2 SUBGRADE PREPARATION

A. All topsoil, organic, and non-compactable materials shall be stripped, screened, stockpiled locally, and protected. Existing subgrade material which will not readily compact shall be removed and replaced with satisfactory materials. Additional materials needed to bring subgrade to required line and grade and to replace unsuitable material removed shall be material conforming to this Section.

B. Subgrade of areas to be surfaced with synthetic turf shall be re-compacted to bring top 9 inches of material immediately below stone base course to a compaction rate of 95%

Standard Proctor in both directions. Subgrade compaction shall extend for a distance of a least one (1) foot beyond turf edge, if not so supported.

C The subgrade shall have a minimum slope of 0.5% or more depending on the soil analysis from the longitudinal center of the field towards the sidelines.

D. The subgrade surface shall not vary from the specified grade by more than ¼" in 10 feet when measured in any direction and shall allow for even drainage.

E. Excavation required in subgrade shall be completed before fine grading and final compaction of subgrade are performed. Where excavation must be performed in completed subgrade, subsequent backfill and compaction shall be performed as specified. Completed subgrade after filling such areas shall be uniformly and properly graded.

F. Areas being graded or compacted shall be kept shaped and drained during construction. Ruts greater than or equal to two (2) inches deep in subgrade, shall be graded out, reshaped, and re-compacted before placing stone base course.

G. Materials shall not be stored or stockpiled on subgrade.

H. Disposal of debris and other material excavated and/or stripped under this section, and material unsuitable for or in excess of requirements for completing work of this Section shall conform to the following:
   1. Material shall be legally disposed of off-site.

I. Laser grading of the subgrade shall be completed per 1.4 A- 3 of this Specification.

J. Prepared subgrade shall be inspected by the Turf Manufacturer's representative. The Turf Installer shall not proceed with installation of stone base course without written approval of the Owner's Representative. Disturbance to subgrade caused by inspection procedures shall be repaired under this Section of the specification.

K. Geotextile fabric shall be laid according to turf Manufacturer's recommendations, specification Section 31 00 00 – Earthwork and as shown on the plans.

3.3 STONE BASE COURSE

A. Stone base course for surfacing and the spreading, grading, and compaction methods employed shall conform to standard requirements for usual base course of this type for first class road work, and the following:
   1. Massachusetts Highway Department Standard Specifications for Highways and Bridges, Latest Edition.

B. The crushed stone shall be laid without damaging the subgrade. The Installer shall also ensure that the crushed stone base and drainage structures are not damaged by heavy equipment.

C. The stone base shall be constructed in layers or lifts less than or equal to six (6) inches thick and of approximate equal thickness, compacted measure. Each layer shall be separately compacted to a compaction rate of 95% Standard Proctor in both directions.

D. The stone base shall have a minimum slope of 0.5% from the center longitudinal center of the field towards the sidelines.

E. The stone base surface shall not vary from the specified grade by more than ¼" in 10 feet when measured in any direction. Stones greater than one (1) inch shall be excluded from course.

F. Width of stone base course shall be greater than or equal to the width of turf surface, if continuous lateral support is provided during rolling, and shall extend at least two (2) x base thickness beyond edge of the course above, if not so supported.

G. Stone base shall be applied in lifts less than or equal to 6 in. thick, compacted measure. Each lift shall be separately compacted to specified density listed in 3.3 C of this specification.
   1. Material shall be placed adjacent to structures only after they have been set to required grade and level.

   2. Surface irregularities which exceed 1/4 inch measured by means of a 10 ft. long straightedge shall be replaced and properly compacted.

H. Subgrade and stone base course shall be kept clean and uncontaminated. Less select materials shall not be permitted to become mixed with gravel. Materials spilled shall not be permitted to become mixed with gravel. Materials spilled outside specified lines shall be removed and areas repaired.

I. Portions of subgrade or of construction above which become contaminated, softened, or dislodged by passing of traffic, or otherwise damaged, shall be cleaned, replaced, and otherwise repaired to conform to the requirements of this specification before proceeding with next operation.

J. Laser grading of the stone base course shall be completed per 1.4 A- 3 of this Specification.

K. Prepared stone base course shall be inspected by the Turf Manufacturer's representative. The Turf Installer shall not proceed with installation of the finished stone without written approval of the Owner's Representative. Disturbance to stone base caused by inspection procedures shall be repaired under this Section of the specification.

L. The Turf Installer shall verify that the subsurface drainage system is functioning properly prior to the commencement of the Infilled Synthetic Turf System installation by thoroughly flooding the field area and verifying and recording flow from the drainage system outlet. Documentation shall be submitted to the Owner's Representative for approval.

M. The Turf Installer shall verify that the surrounding track base is draining properly prior to commencement of the infilled synthetic turf system.

3.4 FINISHING STONE

A. The final grade of the finishing stone shall be two (2) inches thick.

B. The final grade shall be compacted to a compaction rate of 95% Standard Proctor in both directions.

C. The final grade material must be sloped 0.5% from the center longitudinal axis towards the side lines unless otherwise specified.

D. Laser grading of the stone base course shall be completed per 1.4 A- 3 of this Specification.

E. Prepared finishing stone shall be inspected by the Turf Manufacturer's representative. The Turf Installer shall not proceed with installation of the synthetic turf without written approval of the Owner's Representative. Disturbance to the finishing stone caused by inspection procedures shall be repaired under this Section of the specification.

3.5 SYNTHETIC FIELD SURFACING

A. The tufts shall be unfolded prior to installation.

B. All turf seams shall be sewn with a double-locked stitch. Seams shall be combed to ensure that threads are not exposed, but are hidden within the nap.

C. Glued seams will not be permitted.

D. Excess material beyond stitch shall be removed to ensure a level playing surface.

E. Prior to the installation of turf, the Turf Installer shall have surveyed the area to be covered and the longitudinal and lateral center lines and perimeter edge lines shall be located, marked, and staked five (5) feet outside of the actual limits of the turf surface.

F. After acceptance of the constructed base, the carpet shall be laid out on the site and consecutive panels shall be sewn together at the seams.

G. The infill, of cryogenically processed rubber granules and selected graded silica sand, shall be approved by the Manufacturer, and will be inserted according to the Manufacturer's approved procedures.
   1. The bristles of any brooms used, either during the original installation, or in subsequent maintenance, shall be of nylon only, shall under no circumstances include any metal.

H. Field Markings
   1. See Section 2.8 of this specification for information.

I. Installation Limitations
   1. Installation shall not proceed when:
      a. Ambient air temperature is below 40 degrees F.
      b. Material temperature is below 40 degrees F.
      c. Rain is falling or pending, unless acceptable to qualified installers.
      d. Conditions exist, or are pending, that will be unsuitable for the installation of the system.

3.6 PROTECTION

A. The Turf Installer shall advise the Site Contractor and /or General Contractor of procedures required for protection and maintenance of finished synthetic field surfacing during remainder of construction period so that surfacing will be undamaged at time of acceptance.

B. Upon completion of the synthetic field surface, the General Contractor shall be responsible for protection of the field surface for the remainder of the Contract.

END OF SECTION

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Section 32 93 00
SOIL PREPARATION FOR PLANTING BEDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related Sections: The following Sections contain requirements that relate to this Section:
1. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
2. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
3. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

1.2 DESCRIPTION OF WORK

A. Provide all materials, equipment and labor necessary to complete the work as indicated on the drawings, or as specified herein.

B. The principal work of this section includes, but may not be limited to, the following:
1. Mixing of Loam and Compost.
2. Grading and Spreading of Loam/Compost Mix.
3. Application of Limestone.

1.3 QUALITY ASSURANCE

A. Contractor shall specialize in work outlined with a minimum of five (5) years experience on similar projects.

B. Do not make substitutions without written approval. If specified materials are not available, obtain approval for substitution from the Owner's Representative.

1.4 SUBMITTALS

A. The Contractor shall submit representative samples, manufacturer's product data, source of off-site loam to be provided, and certified test results for materials as specified below. Certification shall list soil additives to loam including rates and type.

B. Existing On-Site loam: Sample and test existing on-site loam. The Contractor shall sample the existing loam soils from the construction site with the following requirements:

1. The contractor shall provide a one cubic foot representative sample per each 1,000 cubic yard on-site stockpile of existing loam for testing. All stockpile sampling shall be per ASTM D 75 and Appendixes.

2. Preparation of Samples: Contractor shall place these soil slices into a large, clean plastic container and mix thoroughly. Contractor shall take one cup of soil mixture and dry it room temperature (do not dry samples in an oven or on a stove or radiator). Once soil is dry, place soil in sandwich size type plastic bag and close. Label each sample on outside of bag, identifying sample by soil type and acre.

C. Loam from off-site, if on-site is insufficient: The Contractor shall provide a one cubic foot representative sample per each 1,000 cubic yard proposed stockpile of loam borrow for testing. All stockpile sampling shall be per ASTM D 75 and Appendixes.

D. All testing shall be at the expense of the contractor. Contractor shall deliver samples to the testing facility and have the results forwarded to the Architect. Perform all tests for gradation, organic content, soil chemistry and pH. Testing reports shall include the following tests and recommendations:

1. Mechanical gradation (sieve analysis) shall be performed and compared to the USDA Soil Classification System.
2. Chemical Analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Lead, Zinc, Soluble Salts, extractable Aluminum, Cadmium, Copper, pH and buffer pH. Except where otherwise noted, nutrient tests shall be for available nutrients.
3. Soil analysis tests shall show recommendations for soil additives to correct soils to meet the specifications and for additives necessary to accomplish lawn work as specified.
4. Permeability rates for materials.

E. Compost: Submit supplier's certification of contents.

F. Certification and/or labels of proposed soil additives stating names of each.

G. Sustainable Design Submittals:

1. Recycled content: Provide manufacturer's written certification of recycled content as defined in accordance with International Standard ISO 14021–1999, Environmental Labels and Declarations—Self-Declared Environmental Claims (Type II Environmental Labeling). Indicate post-consumer and pre-consumer recycled content and provide documentation certifying products are from recycled sources. (LEED Credit MRc4).

2. Local/regional materials (LEED Credit MRc5):

   a. Indicate location of content of extraction, harvesting, and recovery; indicate the distance between extraction, harvesting, and recovery and the project site. Indicate percentage of product content from qualified locations.

   b. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.

3. Adhesives and Sealants: Include certification of data indicating Volatile Organic Compound (VOC) content of all field-applied adhesives and sealants and compliance with California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda. Submit MSDS highlighting VOC limits. (LEED Credit IEQc4.1).

1.5 DEFINITIONS

The following definitions shall apply to the work of this section.

The following size distributions of mineral particles by diameter and sieve size shall apply to the following conventional names of soil types:

Conventional Name	Retained on US Sieve No.	Diameter (mm)
Very Coarse Sand	#18	1-2
Coarse Sand	#35	0.5-1
Medium Sand	#60	0.25-0.5
Fine Sand	#140	0.10-0.25
Very Fine Sand	#270	0.05-0.10
Silt	by hydrometer	0.002-0.05
Clay	by hydrometer	Less than 0.002

1.6 PRODUCT DELIVER, STORAGE AND HANDLING

A. Protect all products from weather vandalism or other damaging or deteriorating conditions.

PART 2 - PRODUCTS

2.1 CLEAN SCREENED LOAM

A. Loam shall consist of screened fertile, loose, friable fine sandy loam or sandy loam free of subsoil, refuse, stamps, roots, rocks, cobbles, stones, brush, noxious weeds, litter and other materials which are larger than 1/2 inch (1/2”) in any dimension and which will prevent healthy plant growth.

B. Loam shall be one of the following sandy loams: “coarse sandy loam”, “sandy loam”, “fine sandy loam” based on the USDA Classification System determined by mechanical analysis ASTM D-422. It shall be uniform in composition, without admixture of subsoil. The loam shall possess good filtration and permeability rates, and shall possess a mechanical analysis where:

Sand (0.05 to 2.0 mm)	60% - 70% with no less than 70% of the sand in the medium through very coarse sand fractions (0.25 – 2 mm)
Silt (0.002 to 0.05 mm)	15%-25%
Clay (< 0.002)	10%-20%
Gravel (> 2.0 mm)	<15%

Maximum size shall be three eighths (3/8”) inches largest diameter.

C. Organic Content and pH: Loam shall contain not less than 3% or more than 6% organic matter

D. Acidity range shall be pH 6 to 7.5 in seeded areas when tested according to methods of testing or A.O.A.C.

1. Loam Borrow shall be pH adjusted for particular planting applications and shall be adjusted prior to delivery to the project site.

a. When pH of loam is equal to or greater than 7.5 use aluminum sulfate to adjust pH to required levels.

b. When pH of loam is less than 6 use either sulfur or ferrous sulfate to adjust pH to required levels.

E. The loam borrow must not be handled or moved when in wet or frozen conditions.

F. Loam shall be uncontaminated by salt water, foreign matter and substances harmful to plant growth. Topsoil shall not have extractable aluminum greater than 200 parts per million unless otherwise noted. Cation Exchange Capacity (CEC) shall be between 10 and 15.

2.2 COMPOST

A. Shall be made from aged organic materials, free from sticks, stones and/or other substances which would be injurious to health plant growth.

B. The compost shall be screened to remove all materials one half inch (½”) and larger.

2.3 LIMESTONE

A. Dolomitic limestone contain up to 50% magnesium carbonate in a dry, granular form. Limestone shall be ground to such a fineness that at least 50% will pass through a 100-mesh sieve and 90% to 100% will pass through a 20-mesh sieve.

PART 3 - EXECUTION

3.1 MIXING OF LOAM AND COMPOST

A. Thoroughly mix the Loam and Compost at a rate of 50% each if the materials.

B. The Loam/Compost mix shall be fully and thoroughly blended

3.2 GRADING AND SPREADING OF LOAM/COMPOST MIX

A. Remove all debris and other inorganic materials on any prepared subgrades, and reshape and dress any damaged or eroded slopes, swales, and other areas. Scarify and loosen subgrade to a friable condition in any areas where compaction may have occurred. Loam/Compost shall not be placed until subgrade is in suitable condition and free of excessive moisture or frozen materials. Loam/Compost mix shall be spread to produce a total depth of **12"** as shown on the plan. Fill all depressions in existing grades with suitable fill material as specified in Section 31 00 00 prior to spreading of loam/compost mix, then shape and finish grade to depth required.

3.3 APPLICATION OF LIMESTONE

A. When applied dry, limestone shall be spread evenly and incorporated thoroughly into the soil by discing or other approved means.

B. When applied hydraulically, no discing will be necessary.

C. Granular treatment to be applied at the rate of 25 to 50 lbs. per 1,000 square feet or by soil pH test to produce a pH of 6.0 to 6.5.

END OF SECTION

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Section 32 93 10
TREES, SHRUBS, AND GROUNDCOVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related Sections: The following Sections contain requirements that relate to this Section:
1. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
2. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
3. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

1.2 DESCRIPTION OF WORK

A. Provide all materials, equipment and labor necessary to complete the work as indicated on the drawings or as specified herein.

B. The principal work of this section includes, but may not be limited to, the following:
1. Layout and Excavation of Plant Holes
2. Planting and Backfilling
3. Watering.
4. Mulching.
5. Fertilizing.
6. Staking and Guying.
7. Antidessicant Application.
8. Tags and Labels.
9. Maintenance.
10. Plant Replacement Guarantee.

1.3 REFERENCES

A. ANSI Z260.1 - Nursery Stock, latest edition (American Association of Nurserymen, Inc.).

1.4 QUALITY ASSURANCE

A. Contractor shall specialize in work outlined with a minimum of five (5) years experience on similar projects.

B. An arborist, licensed by the state in which the work is to be performed, is required for all pruning work.

C. At least three (3) shrub of each variety and all trees shall be tagged with a waterproof tag bearing legible designation of botanical and common names, and all other standard products shall be delivered sealed

and unbroken.

D. Do not make substitutions without written approval. If specified landscape material is not available, obtain approval for substitution from the Owner or Owner's Representative.

E. Where formal planting arrangements are shown, select stock with uniform height and spread, and label with numbers to assure symmetry in planting.

F. The Owner and/or the Owner's Representative reserves the right to inspect all plant materials for compliance with specifications, and to reject unsatisfactory or defective work at any time during progress of work.

1.5 SUBMITTALS

A. Certified analysis and source of off-site loam, used to backfill to be provided. Certification shall list soil additives to topsoil, rates and type.

B. Certifications and/or labels of proposed plant materials or substitutions, listing common and scientific names of each.

C. Sustainable Design Submittals:

1. Recycled content: Provide manufacturer's written certification of recycled content as defined in accordance with International Standard ISO 14021–1999, Environmental Labels and Declarations—Self-Declared Environmental Claims (Type II Environmental Labeling). Indicate post-consumer and pre-consumer recycled content and provide documentation certifying products are from recycled sources. (LEED Credit MRc4).

2. Local/regional materials (LEED Credit MRc5):

a. Indicate location of content of extraction, harvesting, and recovery; indicate the distance between extraction, harvesting, and recovery and the project site. Indicate percentage of product content from qualified locations.

b. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.

3. Adhesives and Sealants: Include certification of data indicating Volatile Organic Compound (VOC) content of all field-applied adhesives and sealants and compliance with California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda. Submit MSDS highlighting VOC limits. (LEED Credit IEQc4.1).

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect all products from weather or other damaging or deteriorating conditions.

B. Plants which have been damaged or have deteriorated in transit or storage are not acceptable.

C. Keep plants moist, fresh, and protected against exposure to sun, wind, and freezing temperatures

whether in the receiving yard, in transit, while being handled, or at the job site awaiting planting.

D. Deliver trees, shrubs and groundcover after preparations for planting have been completed and plant immediately.

E. Planting Dates: Prepare a proposed planting schedule. Schedule dates for each type of landscape work during normal seasons for such work. Once the schedule is accepted, dates shall be revised and submitted in writing for reasons of delay.

Planting Deciduous material:	Spring	March 1 to June 15
	Fall	September to December 1
Evergreen material:	Spring	March 15 to May 30
	Fall	August 15 to November 15

F. Those species known to be fall digging hazards shall be dug during the spring season only. Fall planting of these species shall be permitted only with certification, from the nursery, of the time of digging and at the discretion of the Owner or Owner's representative.

G. Correlate planting schedule with specified maintenance periods to provide maintenance to date of acceptance.

H. Coordination with Lawns: Plant trees, shrubs, and groundcover after final grades are established and prior to planting of lawns, unless otherwise acceptable to Owner or Owner's Representative. If planting of trees and shrubs occurs after lawn work, protect lawn areas and promptly repair damage to lawns resulting from planting operations.

1.7 SPECIAL CONDITIONS

A. Should discrepancies exist between plant quantities or plant sizes as shown in the Planting Schedule and on the Planting Plan, quantities and sizes shown on the Planting Plan shall govern. Contractor shall then install all plants as shown on the plan at no additional cost to the owner.

1.8 WARRANTY

A. Provide a warranty for tree, shrub and groundcover plantings for a minimum of one year including one continuous growing season. Commence warranty on date identified in the Certificate of Final Completion.

B. Warranty: Include coverage of plants from death or unhealthy conditions.

C. Replacements: Plants of same size and species as specified, planted as soon as possible in the next growing season, with a new warranty and an extended maintenance service commencing on date of replacement.

1.9 MAINTENANCE

A. Maintenance of tree, shrub and groundcover planting to be performed by Installer Include:
   1. Watering, weeding, cultivating and mulching.
   2. Tightening, guy webbing and repairing of stakes.

3. Replacing of dead material.
4. Resetting plants to proper grades, or to upright position.

PART 2 - PRODUCTS

2.1 LOAM COMPOST MIX

A. For Loam Compost Mix, refer to Section 32 93 00, “Part 2 – Products”.

B. Loam shall consist of screened fertile, loose, friable fine sandy loam or sandy loam free of subsoil, refuse, stamps, roots, rocks, cobbles, stones, brush, noxious weeds, litter and other materials which are larger than one inch (1”) in any dimension and which will prevent healthy plant growth. Organic matter shall constitute not less than five percent (5%) nor more than twenty percent (20%) as determined by wet combustion method (Chromic acid reduction). The Contractor shall notify the Owner or Owner’s Representative of the intended source of loam to be employed at least two (2) weeks prior to the intended time of use to allow time for sampling.

C. Loam shall possess good filtration and permeability rates, and shall possess a mechanical analysis where: N 85% of sand size is 0.5 to 1.0 mm and N 95% of sand mix is between 0.5 and 2.0 mm and no more than 5% of mix is less than 0.5 mm.

D. Acidity range of approximately pH 5.5 to 7.5 when tested according to methods of testing or A.O.A.C. and organic content not less than 5% nor more than 20% as determined by wet combustion method (Chromic acid reduction).

2.2 ANTIDESSICANT

A. Emulsion which permits transpiration while retarding excessive loss of moisture from plants. Deliver in manufacturer's fully identified containers and mix according to manufacturer's direction. Use "Wiltproof" or equal approved.

2.3 TREE AND SHRUB FERTILIZER

A. Fertilizer shall be Organic-based and be OMRI (Organic Materials Review Institute) Certified

B. Complete fertilizer in granular form, from commercial sources bearing manufacturer’s analysis; 2-3-3 ratio of N-P-K.
   1. Total Nitrogen (N) – 2.0%
      a. 0.8% - Water Soluble Nitrogen
      b. 1.2% - Water Insoluble Nitrogen
   2. Available Phosphate (P_2O_5) – 3.0%
   3. Soluble Phosphate (K_2O) – 3.0%

C. Application Rate: Apply 2-3 pounds per 100 square feet

2.4 STAKE AND GUYING MATERIALS

A. Guy web: Shall be a low abrasion woven fiber webbing with a break strength of 900 pounds or better. The width of the webbing shall be no less than 5/8 inch nor greater than ¾ inch. The length shall be sufficient enough to be attached to the tree trunk and stake.

B. Stakes: Shall be on a hardwood source, free of knots, insects and fungi. Stakes shall be of uniform size and shape and shall be a minimum of two inches (2") square. Stakes shall be pointed with a taper of no less than four inches (4").

C. The above ground stake height shall be eight inches (8") above the point of attachment. The type of stakes shall be uniform throughout the job.

2.5 MULCH

A. Pine Bark Mulch shall be derived from evergreen tree bark aged to a minimum of six months and no more than eighteen months. The bark shall be shredded so that the resulting pieces are no more than ¼ inch thick and no longer than three inches (3"). The mulch shall be free of stringy material and shall not contain an excess of fine particles. The mulch shall be brown in color, free of leaves, twigs, sod, weeds, shavings and other foreign materials which are injurious to health plant growth.

2.6 WATER

A. Clean, fresh potable water free from injurious chemicals and other toxic substances harmful to plant life. No brackish water will be permitted.

2.7 PLANT MATERIALS

A. Plant materials shall conform in size, grade and quality to the "American Association of Nurserymen Standards for Nursery Stock" as amended by the United States of America standards institute, in effect at the time of bidding.

B. Plants of other kinds than those named in the Plant Schedule on the Drawings shall not be accepted without written approval of Owner or Owner's Representative.

C. Unless otherwise approved by Owner or Owner's Representative, all plants shall be nursery-grown in accordance with good horticultural practices and shall have been grown under climatic conditions similar to those in the locality of the project for at least two (2) years. They shall have been transplanted or root pruned at least nine (9) months previous to moving to the site.

D. All plant material shall comply with the state and federal law with respect to inspection for plant disease and insect infestation.

E. Replacement plants larger in size than existing may be used if approved by Owner or Owner's Representative, provided use of larger plants does not increase Contract price.

F. If use of larger plants is approved, increase ball of earth of spread of roots in proportion to size of plant.

PART 3 - EXECUTION

3.1 PLANTING

A. Layout: **Determine location of underground utilities and layout plants so as to avoid possible damage to such structures.** Plant pits and bed locations as shown graphically and/or verbally on plans, shall be staked on ground by contractor and approved by the Owner's Representative prior to excavation. Should discrepancies exist between plant quantities in Planting Schedule and Planting Plan, quantities shown on the Planting Plan shall govern. Adjustments in locations and outline shall be made as directed in field. Labor, equipment, and new smooth stakes are to be furnished by the Contractor for this purpose.

B. Excavation: Planting beds and pits shall conform to the approved staked locations and outlines. Holes dug for plantings shall in all cases be large enough to include the complete root system of the plant (tree, shrub, and groundcover) to be received and also sufficient amounts of approved backfill mix around the periphery of the rootball. All sod, weeds, roots, cobbles, and stones and other objectionable materials excavated from the plant holes which is unsuitable for backfill shall be removed from the site immediately and legally disposed of.

C. Plant Hole Size: The minimum plant hole size, unless otherwise specified, shown on the plans or directed by the Owner's Representative shall be as follows:

Trees and Shrubs - The planting hole shall be three (3) times the diameter of the rootball in width and no deeper than two inches (2") less than the distance from the bottom of the rootball to the root collar (i.e. a 12" distance between the bottom of the rootball and the root caller will require a 10" deep hole). Any excavation in excess of that required shall be replaced and compacted to eighty-five percent (85%) of maximum density.

Groundcover - The planting hole shall be twice the diameter of the rootball in width and equal to the depth from the bottom of the rootball to the level at which it was grown in the nursery. Any excavation in excess of that required shall be replaced and compacted to eighty-five percent (85%) of maximum density.

Any rocks or underground obstructions shall be removed to a depth necessary for planting as specified, unless alternate locations for the planting are approved by the Owner's Representative. If removal of obstructions result in a deeper hole than specified for planting, backfill material shall be added and compacted to eighty-five percent (85%) of maximum density to the correct depth.

D. Backfill Mix: Add loam to suitable soil excavated from the planting hole to create mix for planting pits. Backfill Mix shall be at least fifty percent (50%) loam.

3.2 SETTING PLANTS

A. Plants shall be handled in such a manner that the soil of the rootball will not be loosened from the roots. Carefully place plant into the prepared hole. Set plants plumb and fill in around the rootball to one half (1/2) the depth of the hole with backfill mix. Thoroughly tamp the backfill mix to eighty-five percent (85%) of maximum density.

B. Fill remaining area of planting hole with water. Once the water has completely drained loosen burlap and peel down at least the top one-third (1/3). If wire baskets are used, cut and bend down top one third (1/3) of basket. Roots that have been wrapped around the ball within the burlap shall be made to lay in as natural a manner as possible. Cut broken or frayed roots cleanly.

C. Fill remaining area of hole with backfill mix and thoroughly tamp to eighty-five percent (85%) of maximum density. Form a saucer around the edge of through backfill hole by constructing a berm. The finish height of the compacted berm shall be three inches (3"). No excess soil shall be allowed to remain within the plant saucer. Fill saucer with water.

3.3 PRUNING OF NEW PLANT MATERIAL

A. After planting prune only dead, broken or deformed branches and in such manner as to preserve natural character of plant.

B. Perform all pruning with sharp tools, with cuts flush and clean. Do not apply paint or asphalt emulsion tree wound compound on cut area.

C. Trees which have had their leaders cut, or so damaged that cutting is necessary, will not be accepted. There shall be no abrasion of bark, nor fresh cuts of limbs over 1/2".

3.4 WATERING

A. The plants shall be watered immediately following planting.

B. Soak the plants thoroughly again within a twenty-four (24) hour period after the initial planting.

C. Additional watering shall be made at least once every three weeks, unless otherwise directed, until final acceptance of the plant material.

3.5 FERTILIZING

A. During backfill operations, place fertilizer in upper foot of back fill around perimeters as recommended by manufacturer.

3.6 MULCHING PLANTS

A. Application of mulch should only occur after planting operations have been completed and initial watering has taken place. Mulch shall be applied no latter than forty-eight (48) hours after planting.

B. Prior to the placement of mulch, the contractor shall apply a pre-emergent weed control within the entire area to be mulched. Pre-emergent weed control shall be applied by a licensed commercial applicator at a rate in accordance with the manufacturer's installation.

C. Mulch shall be applied a minimum of three (3) inches in depth for all individual trees and planting beds, as indicated graphically or verbally on the drawings.

D. Where mulch abuts seeded lawn areas or other finish grade materials, edge of planting bed shall be cut smooth and cleanly. Mulch shall be placed carefully so as not to spill into adjacent areas. Any excess or spilled mulch shall be promptly removed from the project area.

3.7 GUYING AND STAKING

A. Immediately after planting, stake trees as indicated on detail drawing or as directed by Owner or Owner's Representative.

B. Place stakes outside of the planting pit exercising care not to damage the soil berm.

C. Guy all trees with a caliper of two inch (2") or greater and all evergreen trees greater than four feet (4'). Guy webbing shall be attached at a point no higher than one half (1/2) the height of the tree or lower than one-

third (1/3) the height of the tree.

D. Guy trees to each stake near top of stake and intertwine webbing at tree trunk. The guy webbing shall lay flat against the trunk. Draw guy webbing tight enough to remove slack but shall not cause deflation or strain to the plant.

3.8 TRUNK WRAPPING

A. Remove all trunk wrap and trunk protection devices prior to staking and guying operations unless otherwise directed by the Owner's Representative.

3.9 ANTIDESSICANT SPRAYING

A. Spray antidessicant as directed by the manufacturer's recommendation.

3.10 TAGS AND LABELS

A. Leave all tree tag and label seals unbroken and visible on plant material until final inspection. Remove all seals immediately after final inspection.

3.11 MAINTENANCE

A. Contractor is responsible for protection and maintenance of all work prior to final acceptance. No plants will be accepted unless they show a healthy growth and satisfactory condition.

B. Maintenance work for all plantings shall be as listed in section 1.9.

3.12 PLANTING ON BANKS

A. Apply jute mesh loosely but smoothly to fit the contour of the finished grade, parallel to and in same direction as the flow of water. The up-slope end of each separate strip or piece of jute mesh shall be buried in a six (6) inch minimum vertical anchor slot or junction slot with the soil tamped firmly against the mesh. Where more than one width of material is required, edges shall overlap a minimum of twelve (12) inches, and the up-slope section of mesh will be on top. Down-hill ends of the jute mesh shall be folded under approximately four (4) inches and stapled in place. Staples will be inserted through the mesh along edges, overlaps, and in the center of all jute mesh strips at intervals not greater than three (3) feet. All anchor slots, junction slots, check slots, and terminal folds shall have five (5) staples spaced not more than nine (9) inches on center across widths.

B. On seeded banks, jute shall be applied immediately after seeding. On shrub banks, apply jute after finish grading. Cut openings in mesh for each plant and mulch as specified.

3.13 PLANT REPLACEMENT GUARANTEE

A. Guarantee that, upon completion and final acceptance tree, shrub and groundcover planting conforms to requirements of contract documents and that all plants except transplant materials are healthy and will remain so for a period of one (1) year. Such period shall commence with date of final acceptance.

B. At any times within period of guarantee, Contractor shall replace any plantings which for any reason, other than vandalism, has died or is in a dying condition, or which has failed to flourish in such a manner or to such a degree that its usefulness or appearance has been impaired.

C. The Owner will not maintain plantings until after guarantee period. Contractor shall not have any claim that materials have failed to flourish as a result of Owner's maintenance operations, or lack of maintenance, and shall abide by terms stated herein for guarantee and replacement of plant materials.

D. Decision of Owner as to necessity to replace any plant materials or repair any defects on workmanship, or cause of any destruction or loss, impairment or failure to flourish, shall be conclusive and binding upon Contractor. Replacements shall be of same species and size as specified on Plant List. All plant replacements shall be inspected, sealed, furnished, planted and mulched as specified herein at Contractor's expense.

E. "Vandalism", is intended to mean any acts, whether intentional or accidental, by other persons occurring following final acceptance, which clearly result in breakage or other damage to individual plants or plant beds, and which may reasonable be considered to be beyond Contractor's reasonable control, as determined by the Owner's representative.

END OF SECTION

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Section 32 93 20
SOIL PREPARATION FOR RAIN GARDENS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Related Sections: The following Sections contain requirements that relate to this Section:
1. Section 01 33 29 - SUSTAINABLE DESIGN REPORTING: Special administrative and procedure requirements related to the Owner's LEED 2009 FOR SCHOOLS NEW CONSTRUCTION AND MAJOR RENOVATIONS. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
2. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
3. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

1.2 DESCRIPTION OF WORK

A. Provide all materials, equipment and labor necessary to complete the work as indicated on the drawings, or as specified herein.

B. The principal work of this section includes, but may not be limited to, the following:
1. Mixing of Sand, Loam and Compost
2. Grading and Spreading of Soil Mix

1.3 QUALITY ASSURANCE

A. Contractor shall specialize in work outlined with a minimum of five (5) years experience on similar projects.

B. Contractor shall not make substitutions without written approval. If specified materials are not available, obtain approval for substitution from the Owner's Representative.

1.4 SUBMITTALS

A. Certified analysis and source of off-site loam to be provided. Certification shall list soil additives to loam including rates and type.

B. Certification and/or labels of proposed soil additives stating names of each.

C. Certified analysis and source of compost to be provided.

D. Certified analysis and source of sand to be provided.

E. Sustainable Design Submittals:

1. Recycled content: Provide manufacturer's written certification of recycled content as defined in accordance with International Standard ISO 14021–1999, Environmental Labels and Declarations—Self-Declared Environmental Claims (Type II Environmental Labeling). Indicate post-consumer and pre-consumer recycled content and provide documentation certifying products are from recycled sources. (LEED Credit MRc4).

2. Local/regional materials (LEED Credit MRc5):

a. Indicate location of content of extraction, harvesting, and recovery; indicate the distance between extraction, harvesting, and recovery and the project site. Indicate percentage of product content from qualified locations.

b. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.

3. Adhesives and Sealants: Include certification of data indicating Volatile Organic Compound (VOC) content of all field-applied adhesives and sealants and compliance with California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda. Submit MSDS highlighting VOC limits. (LEED Credit IEQc4.1).

1.5 PRODUCT DELIVER, STORAGE AND HANDLING

A. Protect all products from weather vandalism or other damaging or deteriorating conditions.

PART 2 - PRODUCTS

2.1 SCREENED LOAM

A. Loam shall consist of screened fertile, loose, friable fine sandy loam or sandy loam free of subsoil, refuse, stamps, roots, rocks, cobbles, stones, brush, noxious weeds, litter and other materials which are larger than 1/2 inch (1/2") in any dimension and which will prevent healthy plant growth.

B. Loam shall be one of the following sandy loams: "coarse sandy loam", "sandy loam", "fine sandy loam" based on the USDA Classification System determined by mechanical analysis ASTM D-422. It shall be uniform in composition, without admixture of subsoil. The loam shall possess good filtration and permeability rates, and shall possess a mechanical analysis where:

Sand (0.05 to 2.0 mm)	60% - 70% with no less than 70% of the sand in the medium through very coarse sand fractions (0.25 – 2 mm)
Silt (0.002 to 0.05 mm)	15%-25%
Clay (< 0.002)	10%-20%

Gravel (> 2.0 mm) <15%

Maximum size shall be three eighths (3/8") inches largest diameter.

C. Organic Content and pH: Loam shall contain not less than 3% or more than 6% organic matter

D. Acidity range shall be pH 6 to 7.5 in seeded areas when tested according to methods of testing or A.O.A.C.

1. Loam Borrow shall be pH adjusted for particular planting applications and shall be adjusted prior to delivery to the project site.

a. When pH of loam is equal to or greater than 7.5 use aluminum sulfate to adjust pH to required levels.

b. When pH of loam is less than 6 use either sulfur or ferrous sulfate to adjust pH to required levels.

E. The loam borrow must not be handled or moved when in wet or frozen conditions.

F. Loam shall be uncontaminated by salt water, foreign matter and substances harmful to plant growth. Topsoil shall not have extractable aluminum greater than 200 parts per million unless otherwise noted. Cation Exchange Capacity (CEC) shall be between 10 and 15.

2.2 COMPOST

A. Shall be made from aged organic materials, free from sticks, stones and/or other substances which would be injurious to health plant growth.

B. The compost shall be screened to remove all materials one half inch (½") and larger.

2.3 SAND

A. Sand shall be a gravelly sand meeting ASTM D 422.

B.

Sieve size	Percent passing
2"	100%
¾"	70-100%
¼"	50-80%
No. 40	15-40%
No. 200	0-3%

PART 3 - EXECUTION

3.1 MIXING OF LOAM, SAND AND COMPOST

A. Thoroughly mix the Loam, Sand and Compost at the following percentages:
40% Sand
20-30% Loam
30-40% Compost
Percentages are by volume.

B. The Loam/Compost mix shall be fully and thoroughly blended.

3.2 GRADING AND SPREADING OF SOIL MIX

A. Remove all debris and other inorganic materials on any prepared subgrades, and reshape and dress any damaged or eroded slopes, swales, and other areas. Scarify and loosen subgrade to a friable condition in any areas where compaction may have occurred. Loam/Compost shall not be placed until subgrade is in suitable condition and free of excessive moisture or frozen materials. Loam/Compost mix shall be spread to produce a total depth of **18"** or as otherwise shown on the plan. Fill all depressions in existing grades with suitable fill material as specified in Section 31 00 00 prior to spreading of loam/compost mix, then shape and finish grade to depth required.

END OF SECTION

SECTION 33 05 13

DRAINAGE MANHOLES AND CATCH BASINS

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS, which are hereby, made a part of this Section of the Specifications.

1.2 WORK TO BE PERFORMED

A. The work covered in this Section of the Specifications includes construction and placement of all precast reinforced concrete drainage manholes, catch basins, castings for drain covers and frames, rungs and all appurtenant and incidental work, complete, in strict accordance with the Specifications and the applicable Drawings.

1.3 REFERENCES

A. All work specified in this Section shall conform to the standard requirements of the Town of Plymouth and the Commonwealth of Massachusetts Standard Specifications for Highway and Bridges, latest revision, herein referred to as “State Standards” Specifically Section 200, 230, and 140.

B. American Society for Testing and Materials Standards.

1. All gray iron castings shall conform to the requirements of AASHTO Designation M105, Class 30 and ASTM A48-74. Test both cover and frame, for H-20 Highway Loading.
2. Ductile iron castings shall conform to ASTM A 536. Grade 60-40-18 unless otherwise specified.
3. Cast steel shall conform to ASTM A27. Grade 70-36 and shall be thoroughly annealed.

1.4 SUBMITTALS

A. Submittals for the following items shall be made in accordance with the requirements as specified in Section 01 33 00, SUBMITTAL PROCEDURES.

1. The drawings shall show the setting plans, exact profile of each units, openings required, all inserts and other items which are to be embedded in the units.
2. Shop drawings showing details of manhole cover and frame, catch basin frame and grate, manhole step castings, construction details, tolerances and other information as required.
3. Shop Drawings showing roof drain connectors and/or adapters.
4. Conformance Certificate: Each shipment of castings and concrete manholes and catch basins shall be accompanied with the manufacturer’s notarized certification that materials meet specified requirements.

1.5 QUALITY CONTROL

A. Provide the following.

1. All pre-cast concrete shall be the product of a manufacturer who has demonstrated capability to produce pre-cast concrete products of the quality specified. A manufacturer must be able to show that he has experienced personnel, physical facilities, established quality control procedures, and a management capability sufficient to execute the work of this contract. When requested by the Architect, the Contractor shall submit written evidence of the above requirements.
2. Experienced plant personnel shall closely supervise the manufacturing process, and daily records of concrete strength shall be kept and submitted to the Architect for control.
3. Provide at least one person who shall be present at all times during execution of this portion of the work and who shall be thoroughly trained and experienced in the installation of the pre-cast concrete structures and shall direct all work performed under this Section.

1.6 PRODUCT HANDLING

A. Materials and equipment shall be progressively delivered at the site so that there will be neither delay in the progress of the work nor an accumulation of materials that is not to be used within a reasonable time. Materials shall be so stored as to assure the preservation of their quality and fitness for the work.

B. Stored materials, even though approved before storage, may again be inspected prior to their use in the work. Stored materials shall be located so as to facilitate their prompt inspection.

C. Private property shall not be used for storage purposes without written permission of the owner or lessee, and if requested by the Architect copies of such written permission shall be furnished to him/her. All storage sites shall be restored to their original condition by the Contractor at his expense

1. Avoid damage to castings from impact, abrasion, or corrosion during handling and storage.
2. Use all means necessary to protect pre-cast concrete units and materials before, during and after installation and to protect the installed work and materials for all other trades.
3. In case of damage, immediately make all repairs and replacements necessary to the approval of the Architect and at the Contractor's expense.

PART 2 - MATERIALS

2.1 GENERAL

A. Cement shall be Portland cement conforming to ASTM C150, Type III, high early strength and comply with Standard Specification M4.02.

B. Aggregate: shall conform to ASTM C330 and shall be graded, crushed stone with a resulting unit weight of concrete of up to one hundred fifty five (155) pounds per cubic foot, and a minimum unit weight of not less than one hundred forty-eight (148) pounds.

C. Water: shall be clear and free of injurious and deleterious substances.

D. Concrete: shall have a minimum strength of 5000 psi at twenty-eight (28) days and strength of 3000 psi at the time of form release.

1. During the process of manufacturing of the units not less than two (2) test cylinders shall be tested at time release of the form and two (2) at age twenty-eight (28) days.
2. All compression test cylinders shall be made, cured and stored in accordance with ASTM C31. Cylinders shall be tested in accordance with ASTM C39.
3. All concrete shall contain three (3) to five- (5) percent air entrainment.

E. Admixtures shall only be used after prior approval of the Architect.

F. All reinforcing bars shall conform to the requirements of ASTM designation: A615, Grade 60 and comply with Section 901.61 of the Standard Specification.

G. Welded wire fabric shall conform to the requirements of ASTM designation: A185.

H. All frames and grates shall be H-20.

2.2 PRECAST CONCRETE MANHOLES, CATCH BASINS AND BRICK

A. Precast Concrete Manhole and Catch Basin Sections shall be similar or equal to that shown on the Drawings and shall conform to ASTM Specifications C-478 and C-76 Class IV Wall "B". The horizontal joints between Sections shall be sealed using a flexible butyl resin sealant and shall conform to AASHTO M-198B. In addition, the horizontal joints on the inside and outside of the manhole and catch basin shall be sealed with a "Quick Plug" as manufactured by Parson or equal.

B. Brick shall conform to ASTM Specification C-32 for sewer brick, except that the table therein is amended to provide that the required minimum compressive strength in pounds per square inch shall be for any individual brick 3,000 or 5,000 for the average of five bricks selected at random. The maximum absorption of water by five-hour boiling test shall not exceed 16% for any individual brick or 12% for the average of any five bricks selected at random.

C. Mortar for all brickwork shall be composed of Portland cement and sand in the proportions of 1:2. No mortar cement or lime shall be used. Cement shall be type II Portland Cement as specified for concrete masonry.

D. The dome of the manholes shall be a precast concrete Section. The top 6-inches of the dome, not to exceed 12 inches, shall be built of brick and mortar to permit adjustment of the frame to meet the ground surface.

E. Openings for pipe insertions shall be round and shall be precast or cored only. The diameter of the opening shall be adequate to install a rubber boot seal. The cored or precast opening shall maintain a minimum undisturbed distance of 6” from manhole Section joints. Flexible rubber boot shall be neoprene with stainless steel clamps and bands.

F. The precast bases shall be supported on a compacted level foundation of crushed stone at least 6-inches thick.

G. The barrel shall be at least 48 inches inside diameter with not less than 5 inch thick wall.

H. Sections shall be steam cured and shall not be shipped until at least 5 days after having been cast.

I. The date of manufacture and the name of trademark of the manufacturer shall be clearly marked on the inside of the barrel.

J. The top conical Section shall have a wall thickness not less than 5-inches at the bottom and wall thickness of 8 inches at the top. The conical Section shall taper from a minimum of 48 inches diameter to 36 inches diameter at the top.

2.3 DRAINAGE MANHOLE FRAMES AND COVERS

A. Manhole Frames and Covers shall have a hot-dipped bituminous coating and form to the details on the Drawings. Cast iron shall conform to ASTM A-48, Class 25. The underside of the cover and upper side of lip frame must present parallel plane surfaces, and at these points of contact, the frames and covers shall be machined to prevent covers from rocking in the frames under traffic.

B. Covers shall bear evenly in the frame and both frame seats and covers shall be accurately fabricated so that covers are interchangeable for use with any and all frames. Where indicated, frames and covers shall be watertight, and locked. The sizes and weights (medium duty, heavy duty) are shown on the detail sheets for special manholes.

C. Mortar shall consist of one part cement and two parts clean sand. No lime shall be used.

D. Covers shall have a non-slip surface and shall have the word “DRAIN”, as applicable, inscribed.

E. Frames and covers shall be installed on the manholes as indicated on the Drawings. They shall be well bedded and encased in cement mortar and accurately set to the grades indicated. Red clay brick with cement mortar shall be used to adjust grade of frame and cover. One half inch of cement mortar plaster cast shall be applied to exterior of red clay bricks.

F. All frames shall be designed for H-20 wheel loading.

G. Manhole frames and covers shall be specified by the Town of Plymouth or equal.

2.4 CATCH BASIN FRAMES AND GRATES

A. Catch Basin Frames and Grates shall have a hot-dipped bituminous coating and conform to the details on the drawings. Cast iron shall conform to ASTM A-48, Class 25. The underside of the grate and upper side of lip frame must present parallel plane surfaces, and at these points of contact, the frames and grates shall be machined to prevent grates from rocking in the frames under traffic.

B. Grate shall bear evenly in the frame and both frame seats and grates shall be accurately fabricated so that grate is interchangeable for use with any and all catch basin frames. The sizes and weights (medium duty, heavy duty) are shown on the detail sheets.

C. Mortar shall consist of one part cement and two-part clean sand. No lime shall be used.

D. Gratings shall have a non-slip surface.

E. Gratings shall be installed on the catch basins as indicated on the Drawings. They

shall be well bedded and encased in cement mortar and accurately set to the grades indicated. Red clay brick with cement mortar shall be used to adjust frame and grate. One half inch of cement mortar plaster cast shall be applied to exterior of red clay bricks.

F. Catch basin frames and grates shall be as specified by the Town of Plymouth or equal.

2.5 MANHOLE STEPS

A. Steps shall conform to ASTM C-478.

B. The capacity of each step shall be 1000 lb. At 6-inch distance from wall, 1500 lb. At 4-inch distance from wall.

C. Steps shall measure 12 inches wide (min.) and extend 6 inches from wall.

D. Manhole steps shall be provided in each base, riser and top Section and shall be integrally cast in each; 12 inches O.C.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine the substrate and conditions under which work of this Section is to be performed, and correct unsatisfactory conditions that would prevent proper and timely completion of the work. Do not proceed until satisfactory conditions have been corrected.

1. Examine castings for blowholes, porosity, hard spots, shrinkage, distortion or other defects. Check coating for smoothness and tenacity.

B. The installation of all pipes of various materials, structures, and connections to existing pipes/structures shall be made at the locations and elevations as shown on the drawings.

C. All materials and each part of detail of the work shall be subject to inspection by the Architect. The Architect shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the contractor as is required to make a complete and detailed inspection, (such assistance may include furnishing labor, tools, and equipment, at no expense to the Architect.)

D. If the Architect so requests, the Contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed will be paid for as extra work; but should the work so exposed or examined prove unacceptable, the uncovering or the removing and the replacing of the covering or making good of the parts removed, will be at the Contractor's expense.

E. Any work done or materials used without authorization by the Architect may be ordered removed and replaced at the Contractor's expense. The Contractor shall furnish written information to the Architect stating the original sources of supply of all materials manufactured away from the actual site of the work. In order to insure a proper time sequence for required inspection and approval this information shall be

furnished at least two weeks in advance of the incorporation in the work of any such materials.

F. For the purpose of observing work that affects their respective properties, inspectors for the municipalities, public agencies and the utility companies shall be permitted access to the work, but all official orders and directives to the Contractor will be issued by the Architect.

G. The inspection of the work shall not relive the contractor of any of his obligations to fulfill the terms of the Contract a herein prescribed by the plans and specifications.

H. Failure to reject any defective work or materials shall not in any way prevent later rejection when such defect is discovered, nor obligate the Owner to make final acceptance.

I. The Contractor shall give prior notice to the Architect when work on the various items is to be performed by him or his Subcontractors. If work is suspended on any item, prior notice shall be given to the Architect before resumption of such work.

J. All storm drain lines shall be given combined pressure and leakage tests as detailed by the Town of Plymouth.

3.2 GENERAL

A. Excavation and backfilling requirements for installation of manhole and catch basin structures shall be in accordance with the requirements as specified in Section 31 00 00, Earthwork.

B. Manhole and catch basin barrel and cone Sections shall be set so as to be vertical and in true alignment.

C. Where required for future connections, openings shall be cast in the manholes and catch basins at the proper location and shall be sealed with watertight brick bulkheads or plugs.

D. Drop manholes shall be built in accordance with the details shown on the Drawings and as specified herein.

E. The inverts of all manholes shall be constructed of brick and formed to the details shown on the Drawings.

3.3 CONSTRUCTION AND INSTALLATION

A. Bottom riser Sections of reinforced concrete manholes and catch basins may be either cast-in-place or precast concrete. The top edges, of cast-in-place bottom Sections, shall be formed with a removable steel ring template designed to fit the tongue end of the precast riser Sections.

B. Inverts: Where pipe alignment permits, and where directed by the Architect, the pipe shall be continued through the manhole and the top half carefully and evenly cut away. Where changes in alignment occur, unless otherwise authorized by the Architect, inverts shall be constructed of brick and mortar with a smooth flow line and an even curve in accordance with the plans.

C. Joints: Pipe joints into manholes and catch basins shall be constructed in accordance with the details shown on the plans. Complete details of the boot manufacture and

installation shall be submitted for approval. All areas around pipes passing through walls of manholes and catch basins shall be completely filled with waterproof cement mortar to tightly fill any space through which water can pass. All manhole and catch basin joints between Sections shall also be completely filled with waterproof mortar, both inside and outside, and coated with epoxy sealer inside and out.

D. Bricks shall be laid in a workmanlike manner, true to line, and the joints shall be carefully struck and pointed on the inside. Bricks shall be thoroughly wet when laid and each brick shall be laid in mortar so as to form full bed, end and side joints in one operation. The outside of the brickwork shall be neatly plastered with ½" layer of cement mortar as the work progresses. The brickwork shall be satisfactorily bonded to the concrete and cast iron frame. No brick masonry shall be laid in water, or any water allowed to rise on the brickwork until the masonry has set for at least 24 hours.

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Section 33 10 00

WATER DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 REFERENCES

A. All work specified in this Section shall conform to the Town of Plymouth standards.

B. All work specified in this Section shall confirm to the MASSDEP BRP33 “Distribution System Modifications” permit issued for this project as well as applicable MassDEP public water system regulation.

C. American Water Works Association (AWWA):

1. AWWA C104: Standard for Cement Mortar Lining.
2. AWWA C111: Standard for Rubber Gasket Joints.
3. AWWA C150: Standard for the Thickness Design of Ductile Iron Pipe.
4. AWWA C151: Standard for Ductile Iron Pipe, Centrifugally Cast.
5. AWWA C153: Standard for Ductile Iron Compact Fittings.
6. AWWA C600: Standard for Installation of Ductile Iron Water Mains and Their Appurtenances.
7. AWWA C651: Standard for Disinfecting Water Mains.

1.3 SUMMARY

A. This Section includes water-distribution piping and related components outside the building for water service mains.

B. This Section specifies requirements for furnishing and installing ductile iron pipelines complete and in place for water services.

C. The Contractor shall pay for all costs and fees related to the construction of new water system components and connecting the new water system components to the existing water system including all tap-in and inspection fees and shall file all applications, details and drawings required by the local authority having jurisdiction.

D. Contractor is made aware of the fact the water system at the site constitutes a public water system regulated by the MassDEP.

E. In accordance with MGL chapter 146, section 81 and the State Department of Public safety memorandum dated 6-4-9, all fire mains, hydrants, and underground distribution system components associated with the dedicated fire system must be installed by a sprinkler contractor/sprinkler fitter. Additionally, the installation of fire main/hydrant system must comply with NFPA-24, 2014 as reference by MSBC Chapter 917.

1.4 SUBMITTALS

A. Product Data and Shop Drawings: For each type of product indicated. Submitted and approved by the Architect and the Town of Plymouth.

B. Field quality-control test reports and disinfection notification: The Contractor shall initially notify and subsequently provide the test reports to the Town of Plymouth upon completion of the disinfection and pressure testing.

C. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

D. A copy of any permits required by local authorities having jurisdiction shall be submitted to the Owner prior to commencing work on the water system.

E. Certificate of Compliance:

1. Each shipment of piping, valves, or appurtenances shall be accompanied with the manufacturer's notarized certificate certifying conformance with the requirements of the Specifications.

1.5 PERMIT

A. The Contractor shall maintain a copy of the BRP 33 "Distribution System Modifications" permit issued by the MassDEP at the site at all times during the work of this Contract.

B. The Contractor shall setup a Preconstruction Meeting with the Town of Plymouth to finalize approval of layout and details by The Town of Plymouth prior to commencing work.

C. The Contractor shall obtain all permits required to perform work on the water system without expense to the Owner.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with applicable requirements of the Town of Plymouth including requirements pertaining to the tapping of water mains and backflow prevention.
2. Comply with applicable Town of Plymouth standards for potable-water-service piping, including materials, installation, testing, and disinfection.
3. Comply with MassDEP requirements for water distribution systems.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. All water pipe and appurtenances shall be "American Made".

1.7 DELIVERY, STORAGE, AND HANDLING

A. All delivery, storage, and handling of pipe, valves, hydrants, and appurtenances shall be in accordance with manufacturer's recommendations.

B. Preparation for Transport: Prepare valves according to the following:

1. Ensure that valves are dry and internally protected against rust and corrosion.
2. Protect valves against damage to threaded ends and flange faces.
3. Set valves in best position for handling. Set valves closed to prevent rattling.

C. During Storage: Use precautions for valves, according to the following:
1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

D. Handling: Use sling to handle valves if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

E. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

F. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

G. Protect flanges, fittings, and specialties from moisture and dirt. Piping or materials damaged during delivery storage or handling shall be replaced at the expense of the Contractor.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:
1. Notify Owner in writing no fewer than 2 weeks in advance of proposed interruption of service.
2. Do not proceed with interruption of water-distribution service without Owner's written permission.

1.9 COORDINATION

A. Coordinate connection to existing water system with Plymouth Public Schools facilities personnel.

B. The Contractor shall contact “Dig Safe” at 1-888-Dig-Safe to verify locations of existing underground utilities in areas of proposed excavation prior to commencing any excavation effort.

C. The Contractor shall coordinate any work on the water system with the Town of Plymouth prior to commencing any work on the existing and proposed water system.

D. The installed work will be subject to a final inspection by representatives of the MassDEP Drinking Water Program.

1.10 MARKING

A. Marking of all pipe shall conform to the requirements of AWWA C151, latest revision, and marking of all fittings shall conform to the requirements of AWWA C153, latest revision.

1.11 MANUFACTURER'S REPRESENTATIVE

A. The Contractor shall furnish at no additional expense to the Owner, the services of pipe manufacturer's representatives for instruction of the Contractor's personnel who will be installing the pipe. The instruction shall include proper handling, installation, and jointing and other construction areas, and shall be for such lengths of time required to fully familiarize the Contractor's personnel with the proper techniques.

PART 2 - PRODUCTS

2.1 GENERAL

A. All water appurtenances are to be American made.

B. All materials shall be reviewed and approved prior to installation by the Town of Plymouth.

C. Refer to the Town of Plymouth requirements for a list of approved materials and manufacturers.

2.2 DUCTILE IRON PIPE

A. Ductile iron pipe shall be cement-lined, Class 52, and shall conform to AWWA specifications C150 and C151, latest revision. Ductile iron pipe shall have push-on type joints with the exception that mechanical joints shall be used at all fittings and along straight pipe sections where mechanical joint restraint is required. All pipe shall have a bituminous seal coating on all exterior surfaces.

2.3 FITTINGS

A. Fittings and plugs for use with the ductile iron pipe specified shall be ductile iron, cement lined, bituminous coated with a working pressure rating of not less than 250 psi, conforming to AWWA C153, latest revision, and shall have mechanical joints.

B. The exterior of all fittings, plugs, bolts, and nuts shall be coated with two (2) coats of heavy-duty epoxy protective asphaltic coating after assembly.

C. Bolts and nuts shall be rustproof steel.

2.4 JOINTS

A. Push-on and mechanical type joints for pipe as specified above shall conform to AWWA C111, latest revision. Gasket material for all jointing requirements shall be styrene butadiene (SBR).

B. Lubrication Material is to be food grade quality, kept in original container, and stored according to manufacturer's recommendations.

2.5 CEMENT MORTAR LINING

A. Interior pipe and fitting surfaces shall be covered with a double cement-mortar continuous lining not less than 1/16" thick, of materials, and applied in accordance with AWWA/ANSI C104/A21.4, latest revision.

2.6 STORAGE OF MATERIALS

A. Pipe and related materials shall be stored in locations and in a manner approved by the Engineer. The locations and manner of storage shall be as to minimize handling of the materials.

B. Gaskets are to be stored out of direct sunlight in their original packaging and protected from temperature extremes.

C. The Contractor shall, at all times, be solely responsible for the safe storage of all materials.

2.7 TESTING

A. Manufacturer Testing:

1. Testing of ductile iron pipe shall be done in accordance with AWWA C151, latest revision.
2. Testing of ductile iron fittings shall be done in accordance with AWWA C153, latest revision.
3. Testing of jointing material shall be done in accordance with AWWA C111, latest revision.
4. Testing of the interior coating shall be done in accordance with AWWA C104, latest revision.
5. Certified test reports shall be submitted by the pipe manufacturer.
6. The Engineer shall be notified at least ten (10) days in advance of the date and location of the testing in order to witness the tests.
7. The Contractor shall furnish to the Engineer notarized test reports by an independent testing laboratory, which show compliance of all materials furnished to the requirements specified herein. The test reports shall indicate results and methods employed.

B. Field Testing.

1. Field testing of ductile iron pipe installed for water service shall be performed according to the requirements as specified in Section 3.8 of this specification.

2.8 JOINT RESTRAINT

A. Thrust Blocks are to be designed appropriately for the soils, pipe sizes, and pressures encountered at the job site and are to be installed square and plumb against undisturbed soil so that the joint itself, including any bolts, is accessible. Concrete is to be a minimum compressive strength of 2,000 psi and installed to industry standards.

B. Restraining devices shall be utilized on all mains under the following conditions:

1. Pipeline direction changes (tees, bends).

2. Dead end lines (caps, plugs, valves).
3. Transition pieces (reducers).

C. Thrust restraint may be provided via restrained joint, ductile iron pipe meeting ANSI/AWWA C153, AWWA C151/A21.512, AWWA C111/A21.11, and be approved for use by the Town of Plymouth. Restrained joint pipe lengths (restrained length) shall be sufficient to restrain thrust imparted by 1½ times the anticipated working pressure but not less than 250 psi and may be more than one full length of pipe.

D. Thrust restraint utilizing tie-rods may be used alone or in combination with other restraint systems and are to be installed as directed by the Town of Plymouth authorized field staff. All rods shall be protected from corrosion with two coats of bituminous paint or epoxy prior to backfilling.

2.9 TAPPING SLEEVES AND TAPPING VALVES

A. All tapping sleeves shall comply in all respects to AWWA Standard C-110 and the following design standards:

1. Tapping sleeve shall be installed at the location of the existing water main as shown on the plans and details.
2. The tapping sleeve shall be a mechanical type joint to provide pressure - tight installation and be suitable for use with the existing pressurized pipe material. Outlet flange shall be Class 125C, ANSI B16.1.
3. Mechanical joint tapping sleeves shall have totally confined end gaskets and be designed to withstand a minimum of 250 p.s.i. working pressure.
4. Tapping valves shall comply with Section 2.10 - Gate Valves except one end shall be flanged and the other mechanical.
5. Tapping valves shall be provided with an oversized opening to allow the use of full size cutters.

2.10 GATE VALVES

A. Resilient seated gate valves shall meet AWWA C-509 and be UL listed and FM approved. This valve shall be iron-body, bronze mounted, nonrising stem, 4 inch through 12 inch in diameter as shown on the plans and details. All valves to open as designated by Plymouth Public Schools facilities personnel and the Town of Plymouth Fire Department. All valves to be mechanical joint.

B. Sizes 4 inch through 12 inch shall be suitable for a test pressure of 250-psi.

C. Valve shall have a minimum of two O-ring stem seals.

D. Bonnet and gland bolts and nuts shall be stainless steel for corrosion resistance.

E. The interior and exterior of valves shall be fully epoxy coated 8 mils thick.

F. Gate valves shall be as manufactured by Mueller or equal.

G. Gate valves shall be iron-body, bronze-mounted solid-wedge gate valves, with bell or mechanical joint ends. Valves shall conform to AWWA Standard Specification for Gate Valves, three (3) inch through forty-eight (48) inch for water and other liquids, Designation C500. They shall be double disk type.

H. Buried valves shall be inside-screw, non-rising stem, having bell or mechanical-joint ends and two (2) inch square operating nuts.

I. Bronze gate-rings shall be fitted into grooves of dovetail or similar shape in the gates. For grooves of other shapes, the rings shall be firmly attached to the dates with bronze rivets.

J. Operating nuts shall be turned to the left (counter clockwise) to close all valves.

K. O-ring stuffing boxes shall be used.

L. The T-handle wrenches shall be furnished with each gate valve which shall permit operation from a standing position.

M. All valve boxes shall be adjusted to the final grade.

2.11 STRAIGHT AND TRANSITION PIPE COUPLINGS

A. The center sleeve and end rings of couplings shall be made of ductile iron, meeting or exceeding ASTM A536. The coupling shall accommodate the entire O.D. range in the specified size by use of interchangeable color-coded end rings and gaskets.

B. The coupling gasket shall be made of virgin rubber compound for water use. The SBR shall meet or exceed ASTM D2000-3-BA715. The gasket shall have raised lettering, sizing, and state the proper color code for the appropriate end ring.

C. The coupling shall be equipped with stainless steel bolts, washers, and nuts and conform to the latest edition of the AWWA specification designation C-111 and C-219-06.

D. Straight couplings shall be as manufactured by Ford Model FC1-SH, Smith Blair Model 441, Romac Model 501, Cascade Waterworks Model CDC, or equal.

E. Transitional couplings shall be as manufactured by Ford Model FC2A-SH, Smith Blair Model 441, Romac Model 501, Cascade Waterworks Model CTC, or equal.

F. Straight connections between two ductile iron pipe sections shall be made by ductile iron solid sleeves.

2.12 VALVE BOXES AND COVERS

A. Cast iron valve boxes shall be two-piece adjustable style, sliding type. Barrel inside diameter shall be 5¼ inches with 26-inch top section and 48 inch bottom section lengths adjusted to finish grade.

B. Covers shall be cast iron, 5¼ inch, with the word "WATER" and a direction to open arrow imprinted thereon. Covers shall be the heavy, non-tilting 2” drop style recessed in the top to prevent plow breakage. The boxes and covers shall be compatible with the valves to which they attach.

C. An approved operating key shall be provided to the Owner.

2.13 LIQUID CHLORINE

A. Liquid chlorine shall conform to AWWA Standard B301, current edition. Liquid chlorine shall be NSF 60 certified for potable water use.

2.14 HYPOCHLORITE

A. Hypochlorite shall conform to AWWA Standard B300, current edition. Hypochlorite shall be NSF 60 certified for potable water use.

2.15 BACKFLOW PREVENTER

A. Backflow prevention device used temporarily for any connection between the existing water system and new water pipes prior to acceptance of pressure test, disinfections and flushing, shall be of the appropriate size and shall be double check-reduced pressure type as manufactured by Watts, Febco, Hersey or equivalent. Permanent backflow prevention devices to be installed as part of this project are specified in the plumbing specifications of this Contract.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Section 31 00 00 - Earthwork for excavating, trenching, and backfilling.

3.2 INSTALLATION

A. Water-Main Connection: Tap water main according to requirements of MassDEP and Town of Plymouth standards and of size and in location indicated.

B. In accordance with MGL chapter 146, section 81 and the State Department of Public safety memorandum dated 6-4-9, all fire mains, hydrants, and underground distribution system components associated with the dedicated fire system must be installed by a sprinkler contractor/sprinkler fitter. Additionally, the installation of fire main/hydrant system must comply with NFPA-24, 2014 as reference by MSBC Chapter 917.

C. Pipe, valves, sleeves, hydrants, accessories, and appurtenances shall be new and unused, and shall be of the types and materials specified, as indicated or as directed.

D. The interior of pipe and fittings shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations.

E. Piping, valves, sleeves and other appurtenances shall be constructed in dry trenches and shall not be laid when the conditions of the trench or the weather is unsuitable for such work.

F. The trench bottom and bedding shall be shaped and compacted to give substantially uniform unyielding circumferential support to the lower fourth of the full length of each pipe.

G. Holes for the bells shall be excavated so that after placement the pipe and coupling receives uniform bearing pressure from the trench bottom.

H. Each pipe shall be laid to the line and grade and in such a manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets of the flow line. Joint deflections are limited to 80% of the values specified in AWWA C600-99 Table 3 and 4.

I. As the work progresses, the interior and exterior of the pipes and couplings shall be cleaned of all dirt and superfluous material of every description. Any damage to bituminous coating shall be repaired prior to backfill.

J. When required to keep interior of pipe clean, a suitable drag shall be kept in the pipe and pulled forward past each joint immediately after the jointing has been completed.

K. At times when work is not in progress, open ends of pipe and fittings shall be securely closed with a watertight plug so that no trench water, earth or other substance will enter the pipe or fitting.

L. Any pipe, valve, sleeve, or appurtenance that has been disturbed after laying shall be taken up and re-laid.

M. All materials found to be defective during the progress of the work will be rejected by the Engineer and the Contractor shall promptly remove such defective material from the site of the work and replace with new material at no additional expense to the Owner.

N. The Contractor shall be responsible for the safe storage and proper handling of all materials.

O. No shims or mounds of earth shall be used to raise the pipe to grade.

P. All pipes, valves, sleeves, and appurtenances shall be maintained accurately to the required line and grade.

Q. No pipe, valves, sleeves, and appurtenances shall be covered until the Town of Plymouth has inspected the joints.

R. The pipeline shall not be used to convey trench drainage during construction.

S. Pipes shall be protected at all times during construction against flotation. They shall be thoroughly secured, properly supported and bedded to prevent settlement or disturbance. Compaction of bedding and backfill material shall be in strict accordance with Section 31 00 00 - EARTHWORK.

T. Bends, crosses, tees, caps, plugs, valves, and other appurtenances shall be strapped and clamped where indicated. Steel bars, rods and plates shall be of structural steel. Straps, bridle rods, clamps, anchors and such other parts shall be provided to the details. After installation, all parts of the strapping and clamping devices shall be given two (2) heavy coats of an approved coal-tar base protective coating.

U. All lumps, burrs, excessive coatings, and irregularities on the plain and socket ends of the pipe, valves, sleeves, and appurtenances shall be removed.

V. Field cutting of the pipe is to be square and free of any burrs and defects.

W. Water shall be laid with a minimum horizontal separation of 5’ from all utilities and 10’ from sewer lines. Sewer lines crossing over water lines shall be sleeved for 10 feet on either side of crossing regardless of vertical separation distance. Sewer lines crossing under water lines shall be constructed with a minimum vertical separation of 18” or the sewer shall be constructed of ductile iron or encased in concrete for 10 feet on either side of crossing.

X. Bury piping with depth of cover over top at least 54 inches.

Y. Connect to water-supply source and construct water-service piping to a point 5 feet from the outside face of the building wall in locations and pipe sizes indicated on Drawings. It is the responsibility of the plumber to construct the required piping from this point through the building wall.

Z. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

AA. Valves shall be set in the pipeline as directed. Blocking or supports of a permanent nature shall be placed under each valve to ensure against settlement.

BB. Each valve shall be tightly closed before being placed in the line and shall remain so until the joints on each side are completely tightened.

CC. General:

1. All tapping sleeves, valves and accessories shall be carefully inspected by the contractor for defects before installation and all defective, unsound or damaged materials shall be rejected.
2. The Owner will make such additional inspections as he deems necessary and the Contractor shall furnish all necessary assistance for such inspection.
3. Proper implements, tools and facilities satisfactory to the Owner shall be provided by the Contractor for the proper and satisfactory execution of the work.

DD. All work shall be completed in conformance with the Town of Plymouth requirements.

EE. Tapping sleeves and valves shall be constructed in dry trenches and shall not be laid when the conditions of the trench or the weather is unsuitable for such work.

FF. Tapping sleeves, valves and couplings shall be laid to the line and grade in such a manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets of the flow line.

GG. Any tapping sleeves or valves that have been disturbed after laying shall be taken up and relayed.

HH. All materials found to be defective during the progress of the work will be rejected by the Owner and the Contractor shall promptly remove such defective material from the site of the work and replace with new material at no additional expense to the Owner.

II. The Contractor shall be responsible for the safe storage and proper handling of all materials.

JJ. Tapping sleeves shall be installed where indicated or as directed by the Owner and shall be installed according to the manufacturer's recommended procedures.

KK. Valves and joint restraints shall be installed where indicated or as directed by the Owner and shall be installed according to the manufacturer’s recommended procedures.

3.3 INSPECTION

A. General.

1. All pipe shall be installed in accordance with AWWA C600, latest revision and manufacturer requirements, and in accordance with the Town of Plymouth requirements.
2. All pipe and accessories shall be carefully inspected by the Contractor for defects before installation and all defective unsound or damaged materials shall be rejected.
3. The Engineer will make such additional inspections as he deems necessary and the Contractor shall furnish all necessary assistance for such inspection.
4. Proper implements, tools, and facilities satisfactory to the Engineer shall be provided by the Contractor for the proper and satisfactory execution of the work.
5. The workmanship, materials, and installation are subject to inspection and approval by Town of Plymouth authorized field staff. No installation shall be backfilled prior to inspection.
6. The Town of Plymouth reserves the right to stop work on any water main installation for failure to abide by Town of Plymouth standards until deficiencies are corrected.

3.4 JOINTING

A. No pipes shall be jointed until couplings and ends of pipe have been inspected to determine that the joint surfaces are free from any defects in materials or workmanship, and free from dirt or other foreign matter.

B. Pipe, pipe fittings and accessories shall be stored, installed, joined and protected by the Contractor in strict accordance with the printed recommendations of the manufacturer of the piping material.

C. Field assembled joints shall be checked with a suitable gauge as recommended by the manufacturer to ensure that the rubber rings are properly located.

D. If inspection indicates that the rings are improperly located, the Contractor shall disassemble, and properly reinstall the pipe.

E. Pipe stoppers shall be installed, sealed and blocked in such a manner as to prevent any leakage and so as to withstand an internal hydrostatic pressure of not less than 5 psi.

1. Timber blocking shall be of adequate size and arrangement to prevent the stopper from being blown off the line.
2. Timber bracing shall extend back to the undisturbed end of the trench.

3.5 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping.

3.6 RECORD DRAWINGS

A. All installed underground utilities shall be designated on as-built drawings by the contractor of record and provided to the Owner and Architect in AutoCadd electrical format prior to completion of the project. All as-built drawings, (underground and above ground) shall be dimensioned from permanent benchmarks such as existing buildings and include depths at various points throughout the extent of the work, and invert elevations at all structures.

3.7 SETTING VALVES AND VALVE BOXES

A. Valves shall be set in the pipelines as directed. Blocking or supports of a permanent nature shall be placed under each valve to ensure against settlement.

B. Maximum spacing between valves shall be 600 feet.

C. Each valve shall be tightly closed before being placed in the line and shall remain so until the joints on each side are completely tightened.

D. Valve boxes shall be set for all valves. They shall be carefully fitted together and to the valve and securely held during backfilling. They shall be centered over the valve-operating nut. The bedding material around them shall be thoroughly tamped in placed and the box cover set to the finished grade.

3.8 TESTING

A. Alignment Tests: Each section of pipe will be checked by the Owner or the Engineer in order to determine whether any displacement of the pipe has occurred. The Contractor shall provide suitable assistance to the Owner or the Engineer. The Contractor shall repair any poor alignment, displaced pipe or other defects discovered, as directed by the Engineer.

B. Hydrostatic Tests: After the pipe has been laid and the trench has been backfilled, all newly laid pipe or any valve section thereof, shall be subjected to a pressure and leakage test in accordance with AWWA C600-latest edition and as approved by the Engineer. The Contractor shall provide all pumps, pipe, connections, gages, measuring devices, and all other apparatus necessary for the test and shall conduct the test in the presence of and to the satisfaction of the Engineer. The Owner will supply water to the Contractor for testing purposes at no expense to the Contractor.

1. Test Pressure - The required minimum test pressure shall be 1-1/2 times the working pressure measured at the point of lowest elevation of the pipeline and corrected to the elevation of the test gage, but shall not be less than 150 psi. Test pressures shall not vary by more than plus or minus 5 psi for the duration of the test.
2. Duration of Test - two (2) hours minimum.
3. Air Removal - Prior to performance of the test the pipeline shall be completely filled with water for a period of 72 hours. Expel air by means of air relief valves, hydrants or other means as required. If permanent air vents or taps are not located at all high points, the Contractor shall install corporation stops at such points so air can be expelled. After the tests are completed, plug all temporary taps.
4. Allowable Leakage:
   a. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe or any valve section thereof, to maintain pressure within

5 psi of the specified test pressure after the air in the pipeline has been expelled and the pipe has been filled with water. Leakage shall not be measured by a drop in pressure in a test section over a period of time.

b. No pipe installation will be accepted if the leakage is greater than that determined by the following formula in which "L" is the allowable leakage in gallons per hour; "S" is the length of pipe tested in feet; "P" is the average test pressure during the leakage test in pounds per square inch (gauge); and "D" as the nominal diameter of the pipe in inches.

$$L = \frac{SD\sqrt{P}}{133{,}200}$$

5. Repair of Leaks - If the test discloses leakage greater than the allowable leakage the Contractor shall, at his own expense, locate and repair the defective joints until leakage is within the specified allowable. The Contractor shall repair any specific leaks regardless of the test results if, in the opinion of the Engineer, they are serious enough to endanger the future serviceability of the pipeline.

C. All materials found to be defective during testing shall be replaced with new and approved material at no additional expense to the Owner.

3.9 DISINFECTION OF POTABLE WATER LINES

A. General:

1. Flushing and disinfections of potable waterlines shall be done in accordance with the procedure set forth in AWWA C651 - Disinfecting Water Mains, latest edition, and shall be witnessed by the Engineer unless otherwise approved. The Contractor shall provide all temporary blowoffs, pumps, chlorination equipment, chlorine and all other necessary apparatus required. The Owner will supply water to the Contractor for disinfection purposes at no expense to the Contractor.
2. All valves on the new piping shall be operated during the disinfection procedure in order to ensure complete disinfections.
3. The form of chlorine proposed by the Contractor for disinfection shall be approved by the Engineer.
4. The Contractor shall take adequate measures to prevent backflow of flushing water and chlorinated water into the existing water distribution system.
5. Contractor shall not make physical connection to the existing water main prior to satisfactory results of chlorination. An approved backflow prevention device shall be utilized to transfer water from the existing system to the new piping network.

B. Pipe Cleaning:

1. If the pipe contains dirt or heavy encrusted matter that, in the opinion of the Engineer, will not be removed during the flushing operation, the Contractor shall clean and swab the interior of the pipe with a one (1) percent hypochlorite disinfecting solution.
2. The pipeline shall be flushed to remove all remaining foreign material prior to disinfections, except when the tablet method is used. The flushing operation shall develop a minimum velocity of 2.5 ft/sec. It will be the Contractor's responsibility to properly size and locate corporations within test sections to adequately flush all piping at least 2 times its volume at the desired velocity.

3. Main line valves shall not be utilized to fill, flush, test or chlorinate water mains unless authorized and supervised by the Engineer.

C. Chlorine Application:

1. In general, chlorine shall be applied using the continuous feed method, as specified in AWWA C651.
2. Introduce water into the line at a constant rate while adding chlorine to the water at a constant rate, such that the water will have not less than 25 mg/L free chlorine. Maintain the chlorinated water in the pipeline for a minimum of 24 hours, after which period the treated water shall have a free chlorine residual of not less than 10 mg/L throughout the entire length. Repeat the above procedure if the residual, at the end of the 24 hours, fails to meet the minimum concentration. Chlorinated water, above the normal system prevailing concentration, shall not be allowed to remain in the pipeline for a period longer than 5 days.
3. Fire hydrants may not be used for sampling points but may be utilized as a feed source if properly flushed and the Owner's required temporary piping system installed.

D. Final Flushing:

1. After the required retention period, flush all heavily chlorinated water from the main until the chlorine concentration is no higher than that prevailing in the system, or is acceptable for domestic use. The Contractor shall be responsible for satisfactory disposal of all flushing water and chlorinated water at no additional expense to the Owner.
2. Prior to discharging, a reducing agent shall be applied to the water to be wasted, to neutralize thoroughly the chlorine residual remaining in the water. (See Appendix B of AWWA C651 for neutralizing chemicals.)

E. Analytical Tests:

1. After completion of the final flushing and prior to placing the pipeline in service, two (2) consecutive sets of acceptable samples taken at least 24 hours apart shall be collected. Each sample shall be analyzed for total coliforms. All samples shall be collected by a qualified individual and will be witnessed by the Engineer, who will be given the opportunity to split all samples.
2. All samples shall be collected in laboratory-provided glassware with appropriate preservatives. The laboratory used for testing shall be certified in the Commonwealth of Massachusetts.
3. Sampling locations shall be subject to approval by Engineer and MassDEP.
4. The results of the sampling and analysis shall be reported to Owner and Engineer.

F. Repetition of Procedure - If the original disinfection fails to produce satisfactory bacteriological samples, repeat the disinfection procedure until satisfactory results are obtained at no additional expense to the Owner.

3.10 TEST REPORTS AND CERTIFICATES

A. In addition to other requirements specified herein, the Contractor shall furnish to the Owner notarized test reports and methods of test by an approved independent testing laboratory to show compliance of all materials furnished under this Section of the Specifications with all the requirements herein.

B. Each shipment of pipe, tapping sleeves, valves, and appurtenances shall be accompanied by the manufacturer's notarized certificate of conformance certifying that materials to be furnished under these items meet all requirements herein.

C. All testing of materials furnished under this Section of the Specifications shall be provided by the Contractor at no additional expense to the Owner.

End of Section

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SECTION 33 30 00

SANITARY SEWERAGE UTILITIES (WWTP)
ALTERNATE NO. 1

PART 1 – GENERAL

1.1 CONDITIONS AND REQUIREMENTS

The GENERAL DOCUMENTS, as listed on the Table of Contents, and applicable parts of Division 00 10 00, shall be included in and made part of this Section.

B. Examine all conditions as they exist at the project prior to submitting a bid for the work of this SECTION.

C. Examine all Drawings and all other sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

D. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

E. Any manufacture's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is not a proprietary specification and it should be noted that "or approved equivalent" applies to all products noted herein. It is understood that all manufacturers will have minor variations in configurations, appearance, and product specification to encourage open and competitive involvement from multiple manufacturers that are able to supply similar products.

1.2 SCOPE OF WORK

A. Provide all equipment and materials, and do all work necessary to construct the exterior sanitary sewerage system, complete, including all underground piping, manholes, tanks and connections and connection of the existing underground sewage disposal area as indicated on Drawings and as specified.

B. The work shall also include limited demolition of existing manholes, plugging of existing pipes, removal of existing pumps and controls, (if required), also the removal of existing selected exterior tankage as shown on the Contract Drawings.

C. The Contractor shall pay for all costs and fees related to the construction of the new sewerage system, including all permit, connection and inspection fees and shall file all applications, details, and drawings required by the Town of Plymouth Board of Health and the Commonwealth of Massachusetts, Department of Environmental Protection, Division of Water Pollution Control.

D. The existing RBC Contactors, Clarifiers, Denitrification Filters, and related treatment equipment located inside the existing WWTP building are to be taken out of service after completion of the construction of the new WWTP building and related treatment equipment.

1. After the new WWTP is approved by the Engineer and MA DEP, all liquid and sludge, are to be removed from the existing WWTP equipment inside the existing building.

2. Sewage sludge and liquids are to be removed by a licensed Septage Hauler and transported to an approved DEP Septage Receiving Station.

3. All existing tankage to be power washed and disinfected per MA DEP requirements.

4. Actual dismantling and salvage/removal of all existing WWTP equipment inside the existing WWTP building is within the scope of work under this section.

1.3 RELATED SECTIONS

A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:

1. Section 01 23 00, Alternates: Administrative requirements for alternates affecting work of this section.
2. Section 01 50 00, TEMPORARY FACILITIES AND CONTROLS
3. Section 02 00 00, EXISTING CONDITIONS
4. Section 03 10 00, SITE CLEARING
5. Section 31 20 00, EARTH MOVING
6. Section 32 10 00, BASES, BALLAST, PAVING
7. Section 32 30 00, SITE IMPROVEMENTS
8. Section 32 92 00, TURFS & GRASSES
9. Section 03 30 00 CAST IN PLACE CONCRETE
10. Section 05 00 00, METALS
11. Section 22 00 00, MECHANICAL, PLUMBING
12. Section 26 01 00, WASTEWATER TREATMENT PLANT ELECTRICAL (PART OF 26 00 00)
13. Section 44 41 13, PACKAGE WATER TREATMENT PLANT

1.4 ALTERNATES

A. Refer to Section 01 23 00 – ALTERNATES, for Alternate Number 1 which affects the work of this Section. This alternate adds to the following:

1. Alternate 1 includes all work related to the proposed WWTP as shown on the SS series drawings as well as other related drawings and specifications noted as Alternate 1.

1.5 REFERENCES

A. Codes and Standards: Materials and methods of installation, cleaning, and testing of water system shall comply with local requirements, except where more stringent requirements are indicated.

B. Manufacturers: Firms regularly engaged in manufacture of materials of types and sizes required, whose products have been in satisfactory use in similar service for not less than five years.

C. Massachusetts Plumbing Code: Comply with applicable portions of the current edition of the Commonwealth of Massachusetts Plumbing Code unless more stringent regulations apply.

D. Massachusetts State Electrical Code: Comply with applicable portions of the current edition of the Commonwealth of Massachusetts Electrical Code unless more stringent regulations apply.

E. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirement shall govern.

1. American Society for Testing and Materials (ASTM):

A 48	Gray Iron Castings
A 74	Cast Iron Soil Pipe and Fittings
A 307	Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
A 536	Ductile Iron Castings
C 32	Sewer and Manhole Brick (Made from Clay or Shale)
C 62	Building Brick (Solid Masonry Units Made from Clay or Shale)
C 270	Mortar for Unit Masonry
C 478	Precast Reinforced Concrete Manhole Sections
C 564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
C 891	Installation of Underground Precast Concrete Utility Structures
C 913	Precast Concrete Water and Waste Water Structures
D 2241	Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
D 2321	Underground Installation of Flexible Thermoplastic Sewer Pipe
D 2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipes and Fittings
D 2855	Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
D 3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D 3139	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
D 3212	Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
F 758	Smooth-Wall Polyvinyl Chloride (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage

2. American National Standards Institute (ANSI)

B16.5	Pipe Flanges and Flange Fittings
B31.1	Power Piping

3. American Welding Society (AWS)

B3.0	Welding Procedure and Performance Qualifications

4. American National Standards Institute/American Water Works Association (ANSI/AWWA):

C104/A21.4	Cement-Mortar Lining for Ductile Iron and Gray Iron Pipe and Fittings for Water
C105/A21.5	Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids
C110/A21.10	Ductile Iron and Gray Iron Fittings, 3 in. through 48 in., for Water and Other Liquids.
C111/A21.11	Rubber-Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings
C115/A21.53	Ductile Iron Compact Fittings 3 In., Through 16 In. for Water and Other Liquids
C150/A21.50	Development of Standard Thickness Design of Ductile Iron Pipe
C151/A21.51	Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
C153/A21.53	Ductile Iron Compact Fittings, 3 in. through 16 in., for Water and Other Liquids.
C500	Gate Valves, 3 through 48 In. NPS, for Water and Sewage Systems
C600	Installation of Ductile-Iron Water Mains and Their Appurtenances

5. American Water Works Association (AWWA)

   Manual M11 — Steel Pipe - A Guide for Design and Installation

6. Commonwealth of Massachusetts Highway Department (MHD):

   Standard Specifications for Highways and Bridges

7. Commonwealth of Massachusetts Department of Environmental Protection:

   310 CMR 15.00 et. seq. (Title V of the State Environmental Code), latest edition.

F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.6 EQUALS AND SUBSTITUTIONS

A. All bidders are reminded that the design plans and specifications for the project have been generally based on certain pumping and precast concrete items that have been selected by the Owner and Engineer as meeting their requirements for the project. Any pumping and precast concrete items from any manufacturer that meets all of the requirements of the project specifications and considered “or equal” will be accepted by the Owner.

B. If the use of alternate equipment requiring significant relocation of certain items of equipment or the addition of equipment, accessories or other work, the Contractor shall include all such work necessary to accommodate his proposed substitution in his base bid.

C. The Contractor shall include with his bid a listing of the intended suppliers and manufacturers of the precast concrete items. Each of these suppliers must certify that the material/equipment they intend to supply for the project meets the specifications, (including critical dimensional specifications), and will function to provide the intended result.

1.7 SUBMITTALS

A. The following shall be submitted:

1. DIG SAFE ticket number with the time and date when the site is clear for work.
2. Permit for transport and legal disposal of demolition debris.

B. Contractor's qualifications to perform the work and evidence of a current, valid Town of Plymouth Sewage System Installer's License, (if required).

C. Manufacturer's product data shall be submitted for the following:

Castings
Access Hatchways
Pipe and fittings
Conduit
Tubing
Precast Concrete Manholes
Precast Concrete Pre Anoxic Tank and Aeration Tank
Precast Concrete Post Anoxic Tank
Precast Concrete Dosing Tank
Precast Membrane Drain Sump
Transition Couplings - each type
Check Valves
Valves, Each Type
Valve Boxes
PVC Pipe and Fitting
Schedule 80 PVC Pipe and Fittings
Schedule 40 PVC Pipe and Fittings
Anoxic Tank Pump connections
Transition Couplings
Stainless Steel Pipe`

Submittals shall include material information, dimensions, pipe, fitting and valve class information, weights, coating and lining system data. The Contractor shall supply the Engineer with manufacturer Certificates of Compliance with these Specifications and certification that the pipe, fittings and valves have been manufactured and tested in accordance with AWWA/ANSI specifications.

D. Shop drawings shall be submitted for each of the following:

1. Precast Concrete manholes
2. Precast Pre Anoxic & Aeration Tank
3. Precast Concrete Post Anoxic Tank
4. Precast Concrete Dosing Tank
5. Precast Membrane Drain Sump
6. Access Hatchways

Shop drawings, structural design calculations all of which are signed and sealed by a Massachusetts Registered Professional Structural Engineer shall be required for all precast concrete tanks. Structural calculations shall be based on the design cover conditions, H-20 loading and groundwater based on the existing site conditions. Floatation calculations shall be based on historic groundwater elevation of the existing site.

1.8 OPERATION AND MAINTENANCE INSTRUCTIONS

A. All equipment manufacturers shall be responsible for supplying written instructions, which shall be sufficiently comprehensive to enable the installer and operator of the equipment to operate and maintain the equipment supplied. Said instructions may assume that the operator is familiar with pumps, motors, piping, and valves, but that he has not previously operated and/or maintained the exact equipment supplied.

B. These instructions shall be prepared as a systems manual applicable solely to the equipment supplied by the manufacturer to these specifications, and shall include those devices and equipment supplied by him.

C. The instructions shall include, but no be limited to, the following:

1. Descriptions of, installation procedures for and operating instructions for, each major component of the equipment supplied.
2. Instructions for operation of the equipment in all intended modes of operation.
3. Instructions for all adjustments which must be performed at initial startup of the equipment, adjustments which must be performed after the replacement of components and adjustments which must be performed in the course of preventive maintenance as specified by the manufacturer.
4. Instructions for the adjustment, calibration, and testing of selected electronic components or assemblies, normally considered replaceable by the manufacturer, whose performance is not ascertainable by visual inspection.
5. Service instructions for major components not manufactured by the equipment manufacturer but which are supplied by him in accordance with these specifications. The incorporation of literature produced by the actual component manufacturer shall be acceptable.

D. Operation and maintenance instructions which are limited to a collection of component manufacturer literature without overall operational instructions related to this specific installation shall not be acceptable.

E. Operation and maintenance instructions shall be specific to the equipment supplied in accordance with these specifications. Instruction manuals applicable to many different configurations and which require the operator to selectively read portions of the instructions, shall not be acceptable.

1.9 QUALITY ASSURANCE

A. The entire work provided in this section shall be constructed and finished in every respect in a workmanlike and substantial manner, in strict accordance with the Drawings and specifications. It is intended that the Drawings along with the manufacturer's shop drawings substantially show all pipe, fittings and appliances; however, the Contractor

shall furnish and install such parts as may be necessary to complete the systems in accordance with the best trade practice and to the satisfaction of the Engineer.

B. The Contractor shall refer to all the drawings for a full comprehension of the work to be done and coordinate the work with other trades to avoid interference. Should any discrepancy appear or any misunderstandings arise, the Contractor shall request clarification by the Engineer.

C. The Contractor shall be responsible for fully coordinating all of the various parts of the work included under this section, and such other work of this contract as it may affect the work of this section throughout various phases of construction and before the ordering or fabrication of the various parts of the work, so as to insure compliance with the drawings and specifications, and as necessary to provide performance in conformity with design requirements and satisfactory operating condition and operating sequences. Cooperate with such trades to assure the steady progress of all work under the Contract.

D. Source: For each type of material required for the work of this section, provide primary materials which are the products of one manufacturer. Provide secondary materials which are acceptable to the manufacturers of the primary materials.

E. The Contractor shall provide manufacturer's certification that materials meet or exceed minimum requirements as specified. Reference to standards such as ASTM and ANSI shall apply to those versions in effect at the time of bid opening.

F. Guarantees: In addition to the specific guarantee requirements of the General Conditions, the Contractor shall obtain extended guarantees for materials furnished under this section where such guarantees are offered in the manufacturer's published data. All these guarantees shall be in addition to, and not in lieu of, other liabilities which the Contractor may have by law or other provisions of the Contract Documents. The Town of Plymouth requires a two year warranty for products and installation under this section. **(CRITICAL)**

1.10 DELIVERY, STORAGE AND HANDLING

A. All equipment and accessories shall be transported, unloaded, stored and handled in strict accordance with the manufacturer's instructions and recommendations. Protect from all possible damage.

1.11 TOWN OF PLYMOUTH AND STATE REQUIREMENTS

A. The Contractor shall notify and make all necessary arrangements with the Town of Plymouth Board of Health and the Commonwealth of Massachusetts, Department of Environmental Protection, Division of Water Pollution Control sufficiently in advance of the installation of the WWTP equipment for any testing and inspection to occur.

B. All work and materials for the WWTP system installation shall be subject to approval of the Town of Plymouth Board of Health and the Commonwealth of Massachusetts, Department of Environmental Protection, Division of Water Pollution Control.

C. The Contractor shall be responsible for making all arrangements with the Town of Plymouth Board of Health and the Commonwealth of Massachusetts, Department of Environmental Protection, Division of Water Pollution Control and for paying all fees associated with the sewage disposal system installation, testing and inspection.

D. Comply with the rules, regulations, laws and ordinances of the Town of Plymouth, the Commonwealth of Massachusetts, appropriate agencies of the Commonwealth of Massachusetts, and all other authorities having jurisdiction. Coordinate all work done within Town of Plymouth rights of way with the appropriate agencies. All labor, materials, equipment and services necessary to make the work comply with such requirements shall be provided without additional cost to the Owner.

E. Comply with the provisions of the Manual of Accident Prevention in Construction of the Associated General Contractors of America, Inc., and the requirements of the Occupational Safety and Health Administration (OSHA), United States Department of Labor.

F. The Contractor shall procure and pay for all permits and licenses required for the complete work specified herein and shown on the Drawings.

G. The Contractor shall not close or obstruct any street, driveway, sidewalk, or passageway unless authorized in writing by the Engineer. The Contractor shall so conduct his operations as to interfere as little as possible with the use ordinarily made of roads, driveways, sidewalks or other facilities near enough to the work to be affected hereby. The Contractor shall comply with the time limits established by the terms for trucking onto and off of the site.

H. Any apparent conflict between the Drawings and Specifications and the applicable codes and regulations shall be referred to the Engineer in writing, for resolution before the work is started.

I. The Contractor shall notify "Dig Safe" and all local utility companies prior to the start of construction. The "Dig Safe" number shall be submitted by the Contractor in writing to the Engineer and Owner prior to construction along with copies of written notification to the local utility companies.

J. The contractor shall conform to all of the requirements of all of the permits in performing the work including the MGL Ch. 131, s40 Order of Conditions and Determination of Applicability.

1.12 INSPECTION AND TESTING

A. Pipe, precast structures and castings shall be inspected and tested by the manufacturer by the standard specifications to which the material is manufactured.

B. The Owner reserves the right to have any or all pipe, precast structures and castings inspected and/or tested by an independent testing agency at manufacturer's plant or elsewhere. Such inspection and tests shall be at the Owner's expense.

C. Pipe, precast structures and castings shall be subjected to a careful inspection by the Contractor just before being installed.

D. The Contractor shall be responsible for performing all tests required by the Town of Plymouth Board of Health, the Commonwealth of Massachusetts, Department of Environmental Protection, Division of Water Pollution Control and the Engineer.

1.13 CONTRACTOR QUALIFICATIONS

A. Contractor installing the WWTP system shall have a minimum of three (3) years experience in work of the type required by this section and shall have installed at least 5 systems with a design flow equal to or greater than the design flow for this project.

1.14 INFORMATION

A. It is hereby understood that the Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of lack of full knowledge of existing conditions.

B. Plans, surveys, measurements and dimensions, under which the work is to be performed are believed to be correct to the best of the Engineer's knowledge, but the Contractor shall have examined them for himself during the bidding period, as no allowance will be made for any errors or inaccuracies that may be found herein.

C. Information on the Drawings and in the Specifications relating to subsurface conditions, natural phenomena, and existing utilities and structures is from the best sources presently available. Such information is furnished only for the information and convenience of the Contractor, and the accuracy or completeness of this information is not guaranteed.

D. Subsurface information is contained in the geotechnical report which has been prepared for the Owner by Pare Corporation, Foxboro, MA.

1.15 EXISTING CONDITIONS

A. The Contractor shall become thoroughly familiar with the site, consult records and drawings of adjacent structures and of existing utilities and their connections, and note all conditions which may influence the work of this Section.

B. By submitting a bid, the Contractor affirms that he has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of lack of full knowledge of existing conditions.

C. The Contractor may, at his own expense, conduct additional subsurface testing for his own information.

1.16 DISPOSITION OF EXISTING UTILITIES

A. Active utilities existing on the site and work areas shall be carefully protected from damage and relocated, rerouted or removed. When an active utility line is exposed during construction, its location and elevation shall be plotted on the record drawings as described in this Section and the Engineer, Owner and the Utility Owner notified in writing.

B. Inactive or abandoned utilities encountered during construction operations shall be removed if within a building area or grouted, plugged or capped. The location of such utilities shall be noted on the record drawings and reported in writing to the Engineer and Owner.

1.17 PROTECTION

A. Do not interfere with use of adjacent buildings. Maintain free and safe passage to and from all adjacent buildings and buildings on the site to remain.

B. Cease operations and notify Engineer immediately if safety of adjacent structures appears to be endangered. Take precautions to properly support structures. Do not resume operations until safety is restored.

C. Prevent movement, settlement or collapse of adjacent services, sidewalks, driveways and trees. Assume liability for such movement, settlement, or collapse. Promptly repair damage at no cost to the Owner.

D. Provide, erect, and maintain street boardings, sidewalk shed, barricades, lighting, and guardrails to protect general public, workers, and adjoining property.

1.18 MAINTAINING TRAFFIC

A. Do not close or obstruct roadways without permits. Access to the existing school buildings on site must be maintained.

B. Conduct operations with minimum interference to public or private roadways.

C. Refer to the Massachusetts Highway Department Access and Utility Construction permits for special conditions regarding safety and the maintenance of traffic flow on state highways.

1.19 MAINTENANCE OF EXISTING FLOW

A. The Contractor shall schedule his work so as to maintain sewage flow within the existing waste treatment system until the new waste treatment system is fully constructed, tested and approved for operation. This provision may require the use of temporary pumps, pipes or connections, all of which shall be provided by the Contractor.

PART 2 - PRODUCTS

2.1 PIPE STUB MARKER

A. Pipe stub markers shall be 2 in. by 2 in. solid oak stakes with a 2 in. by 1/16 in. by 12 in. galvanized steel strap screwed to the top end.

2.2 WALKWAY, PAVING AND CURBING REPAIR FOR TEST PITS

A. Any materials necessary to repair walkways, pavements or curbings damaged by the excavation of test pits shall match the existing material types and the specifications contained in Section 32 00 00 of these specifications.

2.3 LAWN REPAIR FOR TEST PITS

A. Any materials necessary to repair lawns damaged by the excavation of test pits shall match the existing material types and the specifications contained in Section 32 12 16 of these specifications.

2.4 UTILITY REPAIRS

A. Any materials necessary to repair underground utility lines damaged by the excavation of test pits shall match the existing material types and the relevant sections of these specifications or the specifications of the appropriate utility company.

2.5 PVC SEWER AND VENT PIPE

A. Vent pipe shall be Poly (Vinyl Chloride) (PVC) non pressure pipe and conform to ASTM D3034, SDR 35 minimum wall thickness for solid wall pipe.

2.6 PVC PIPE AND FITTINGS

A. Polyvinyl chloride (PVC) nonpressure pipe for gravity sewers shown on the MEA WWTP contract drawings shall conform to ASTM D 3034, SDR35 minimum wall thickness for solid wall pipe or approved equal.

B. Pipe shall be bell-and-spigot in standard lengths of 12 feet 6 inches.

C. Bell end shall be an integral wall section with solid cross section rubber ring, factory assembled.

D. Spigot end shall be beveled to ensure proper insertion. Spigot end shall be imprinted with assembly stripe, to which the bell end of the mated pipe will extend upon proper jointing.

E. Rubber rings shall conform to ASTM D 3212.

F. Pipe ends shall permit checking of the rings with a feeler gage to ensure their proper location in the coupling grooves.

G. PVC fittings shall be bell-and-spigot type, compatible with the pipe. PVC pipe and fittings as manufactured by Zhejiang Nanfeng Pipe Industry Co., Shanghai, Tomson Plastic Industry, Yuyao Jiachi Pipe Co. LTD, or approved equal.

H. Pipe couplings shall be Fernco type with stainless steel bands. Fernco couplings provided by Fastenal Co., Bellflower & Lakewood Steel & Pipe Utilities Supply Corp., or approved equal.

2.7 SCHEDULE 80 PVC SOLID PIPE AND FITTINGS (PRESSURE PIPE FOR PIPING BETWEEN TANKS AND INSIDE TANKS)

A. Pipe and fittings shall be manufactured from a PVC compound which meets the requirements of Cell Classification 12454-B, Polyvinyl Chloride as outlined in ASTM D 1784. PVC shall be white in color. Pipe and fitting materials shall be specifically formulated with sufficient UV screeners to provide for long term outdoor exposure with no deleterious effects. Pipe shall be pressure rated.

B. Materials from which fittings and pipe are manufactured shall have been tested and listed for conveying potable water by the National Sanitation Foundation (NSF).

C. Fitting components with socket type solvent cement connections shall have socket diameters, lengths, and wall thicknesses as prescribed by ASTM D 2146.

D. Pipe shall have diameters and wall thicknesses as prescribed by ASTM D 1785 for pressure rated pipe.

E. Solvent cemented pipe and fittings shall be pressure rated accordance with the requirements of ASTM D 1785 and ASTM D 2146, respectively.

F. Pipe and fittings shall be clearly marked in accordance with the requirements of ASTM D 1785 and ASTM D 2146, respectively.

G. Pipe shall meet all of the requirements of Title V of the State of Massachusetts Environmental Code.

H. Schedule 80 PVC Pipe as manufactured by Zhejiang Liutong Plastic Co., LTD, Cangzhou Haoguan Manufacturing Pipe Fitting Co. LTD, Hangzhoo Hotool Pipe Tool Factory, or approved equal.

2.8 DUCTILE IRON PIPE AND FITTINGS (IF SHOWN ON CONTRACT DRAWINGS)

A. Ductile iron pipe shall be that of a United States manufacturer who can demonstrate at least 5 years of successful experience in manufacturing ductile iron pipe. The pipe shall be equipped with push-on type, restrained joint, or mechanical joints.

B. Ductile iron (DI) pipe for sewer force main and gravity sewer to be designed in accordance with ANSI/AWWA C150/A21.50 and shall be manufactured in accordance with ANSI/AWWA C151/A21.51. Unless otherwise indicated or specified, ductile iron pipe shall be at least thickness Class 52 with a rated working pressure of 150 psi (surge pressure = 300 psi) and furnished in nominal 18-foot lengths, with Push-on or Mechanical Joints as manufactured by U.S. Pipe and Foundry Company, Clow Corporation, American Cast Iron Pipe, or approved equal with gaskets conforming to AWWA C111 ANSI A21.11 "Rubber Gasket Joints".

1. DI pipe for sewers and force mains may be either mechanical joint or push on joint.

2. DI pipe inside the pump stations and all underground tanks and under the floor of the new wastewater treatment building shall be flanged joint only.

3. Pipe shall be supplied in 20 foot lengths along with necessary materials and equipment recommended by the manufacturer for use in joining pipe lengths and fittings.

4. Fittings shall be compact ductile iron Class 350 Mechanical Joint, conforming to ANSI Specification A21.53 (AWWA) C153), latest edition, for pipe sizes 16-inches and smaller, and Class 350 standard Mechanical Joint fittings conforming to AWWA C110/ANSI A21.10, latest edition except as specified, for pipe sizes 16 through 24-inches, unless specifically stated otherwise in the Specifications or on the Drawings. Fittings shall be suitable for use with restraints as specified hereinafter. Fittings shall be manufactured in the United States. Fittings shall be of the same material and have the same lining and coating as the pipe specified above. All fittings shall be marked with the weight and shall have distinctly cast upon them the pressure rating, the manufacturer's identification, nominal diameter of openings and the number of degrees or fraction of the circle on all bends.

5. DI fittings inside all tanks shall be flanged joint type and shall conform to ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53 and shall further conform to the applicable requirements of MHD Standard Specification M5.05.3. All fittings shall be minimum Class 350.

6. Retainer glands shall be used at all mechanical joints and shall be of ductile iron construction conforming to ASTM A 536. All retainer glands shall be U.L. and F.M. approved. All retainer glands shall be furnished with ductile iron set screws. Set screws shall be torque to 70 ft-lbs. Restraints for mechanical joints shall be Megalug as manufactured by Ebaa Iron Co., Mechanical Joint Restraint (MJR) System as manufactured by Tyler Pipe or equal. Restraints for push-on joints shall be Series 800 Coverall as manufactured by Ebaa Iron Co., Star Pipe, Inc., Qingdao Voltech Manufacturing Co. LTD.

7. Gaskets shall conform to ANSI/AWWA C111/A21.11.

8. Inside of pipe and fittings shall be given a double thickness cement lining and bituminous seal coat in accordance with ANSI/AWWA C104/A21.4. The outside of pipe and fittings shall be coated with a standard bituminous coating conforming to ANSI/AWWA C151/A21.51 and C110/A21.10, respectively.

9. Pipe for use with sleeve-type couplings shall be as specified above except that the ends shall be plain (without bells or beads). The ends shall be cast or machined at right angles to the axis.

10. The Contractor shall provide all adapters and fittings such as transition couplings, as determined in the field, necessary to complete all cross-connections, whether or not specifically stated in the Contract Drawings and Specifications.

C. Pipe and fittings shall meet all of the requirements of Title V of the State of Massachusetts Environmental Code as well as the requirements of 310 CMR 15.00 et. seq.

2.9 SCHEDULE 40 SOLID PRESSURE RATED PVC PIPE AND FITTINGS PRESSURE PIPE FOR FORCEMAIN PIPING TO THE EXISTING DISPOSAL AREA, AND VENT PIPING (WHERE SHOWN)

A. Pipe and fittings shall be manufactured from a PVC compound which meets the requirements of Cell Classification 12454-B, Polyvinyl Chloride as outlined in ASTM D 1784. PVC shall be white in color. Pipe and fitting materials shall be specifically formulated with sufficient UV screeners to provide for long term outdoor exposure with no deleterious effects. Pipe shall be pressure rated.

B. Materials from which fittings and pipe are manufactured shall have been tested and listed for conveying potable water by the National Sanitation Foundation (NSF).

C. Fitting components with socket type solvent cement connections shall have socket diameters, lengths, and wall thicknesses as prescribed by ASTM D 2467.

D. Pipe shall have diameters and wall thicknesses as prescribed by ASTM D 1785 for pressure rated pipe.

E. Solvent cemented pipe and fittings shall be pressure rated accordance with the requirements of ASTM D 1785 and ASTM D 2467, respectively.

F. Pipe and fittings shall be clearly marked in accordance with the requirements of ASTM D 1785 and ASTM D 2467, respectively.

G. Pipe shall meet all of the requirements of Title V of the Commonwealth of Massachusetts Environmental Code.

H. Schedule 40 pressure rated PVC pipe and fittings as provided by Charlotte Pipe & Foundry, U.S. Plastics, Aetna Plastics Corp., or approved equal.

2.10 PVC VALVES

A. Butterfly Valves PVC Body
Butterfly valves and operators for wastewater piping shall conform to AWWA Standard Specifications for rubber seated butterfly valves. Designation C504, except as herein specified. Valves shall have minimum 150 psi pressure rating and be equal to those manufactured by Colonial Engineering, Inc., Hayward Valves, L.D. Valve Co., U.S. Plastics, or approved equal. Valve body shall be Type 1, Grade 1 PVC.

B. Gate Valves
Gate valves for PVC pipe in plant influent, process water and effluent lines to Dosing Tank shall be PVC Type 1, Grade 1 as manufactured by Asatii/America, Hayward Valves, L.D. Valve Co., LTD, U.S. Plastics Corp., or approved equal. Valves shall have a non-rising stem with a visible position indicator. Valves shall be provided with an operating wheel. Valve bodies shall be flanged and type (unless otherwise approved). All valves shall be mounted in such a position that valve position indicators are plainly visible when standing on the floor.

C. Ball Valves
Ball valves for the PVC pipe in plant influent/effluent lines upstream of Dosing Tank shall be of PVC Type 1, Grade 1 as manufactured by Asatii/America, Hayward Valves, L.D. Valve Co., or approved equal. Valve bodies shall be double union type supplied with flange adapters, unless otherwise approved. All valves shall be mounted in such a position that valve position indicators are plainly visible when standing on the floor.

2.11 BUTTERFLY VALVES (METAL BODY)

A. Butterfly Valves (Metal Body)

1. Butterfly valves and operators for low pressure air, piping shall conform to the AWWA Standard Specification for rubber seated butterfly valves, Designation C504, except as hereinafter specified. Valves shall have a minimum 150 psi pressure rating and be equal to those manufactured by Henry Pratt Company, Crispin Valves, Triad Process Equipment, or equal.

2. Butterfly valves shall be flanged end with face to face dimensions in accordance with Table 2 of above mentioned AWWA Specification for short-body valve, or wafer type.

3. Valve seats shall be full resilient seats retained in the body or on the disc edge in accordance with Section 8 of the above mentioned AWWA Specification. If the resilient seat is in the body, the disc shall be of cast ni-resist conforming to ASTM A436 Type 1 with the periphery machined to a smooth spherical surface. If the resilient seat is mounted on the disc edge it shall be held in place by a one-piece Type 304 stainless steel retaining ring and stainless Nylock screws, the disc shall be of ASTM A48, Class 40 cast iron and a mating Type 304 stainless steel ring shall be installed in the valve body. Resilient seats shall be Hycar or equal for water service and Nordel or equal for air service. Resilient seats in valves for air service shall be mounted in the body only.

4. The valve body shall be constructed of close grain cast iron per ASTM A126, Class B with integrally cast hubs for shaft bearing housings of the through boss-type. Permanently self-lubricating body bushings shall be provided and shall be sized to withstand bearing loads. Stuffing box of liberal dimensions shall be provided at the operator end of the vane shaft, arranged so that the packing can be replaced by removing the bronze follower without removing the operator. Packing shall be of the Chevron type as manufactured by Garlock Packing Company. A sealing element utilizing 0-rings shall also be acceptable.

5. The valve shaft shall be of type 304 stainless steel and designed for both torsional and shearing stresses when the valve is operated under its greatest dynamic or seating torque.

6. In general, the butterfly valve operators shall conform to the requirements of Section 3.8 of the AWWA Standard Specifications for Rubber Seated Butterfly Valves, Designation C504, insofar as applicable and as herein specified.

7. Gearing for the operators where required shall be totally enclosed in a gear case in accordance with Section 3.8.3 of the above mentioned AWWA Standard Specification.

8. The manual operators shall conform to Section 3.8.1 of the above mentioned AWWA Standard Specifications, insofar as applicable. Valves shall have hand wheel or lever operators and open left, or counterclockwise. Operators shall have indicators to show position of the valve disc. Operators shall be rigidly attached to the valve body.

2.12 POLYPROPLENE TUBING

A. Polypropylene tubing for alkalinity and carbon feed lines shall be Type 1 polypropylene conforming to ASTM D-2146 with a stress of 112 psi @ 70 degrees F. Tubing shall be installed without any joints or splices. Tubing shall be ½” diameter, US Plastic Corp. or approved equal. Polypropylene tubing to be installed inside long sweep curved PVC piping. Tubing as provided by Uline Corp., U.S. Plastics, Omega Co., or approved equal.

2.13 SLEEVE TYPE TRANSITION COUPLINGS

A. Sleeve-type couplings shall be cast iron and shall be Dresser Style 53, manufactured by Dresser Mfg. Div., Bradford, PA; Smith-Blair Style 441, manufactured by Smith-Blair, Inc., San Francisco, CA; Clow Type F-1208, manufactured by Clow Corporation, Rochester, NY; or approved equal.

1. To ensure correct fitting of pipe and couplings, sleeve-type couplings and accessories shall be furnished by the supplier of the pipe and shall be of a pressure rating at least equal to that of the pipeline in which they are to be installed.
2. Couplings shall be provided with galvanized steel bolts and nuts.
3. Couplings shall be furnished with the pipe stop removed.

B. Penetration Seals: Between Flow Equalization Tank and Pump Chamber there shall be a link seal type rubber seal with adjustable links to expand to pipe size. Link seal type connector to be provided by Trubull Mgr. Co., Pipeline Seal, RPH Distributors LTD, Flex Craft Industries, or approved equal.

2.14 STAINLESS STEEL PIPE (AIR PROCESS SUPPLY)

A. Stainless steel shall be seamless and 316 Grade Stainless Steel piping and shall be used for all process air lines below floor grades. Fittings shall be 316 Stainless Steel. Joint for fitting shall be threaded for standard screwed joints or welded joints. (Submittal required). Stainless Steel pipe manufactured/supplied by Quality Pipe Products Inc., American Piping Products, American Stainless Supply.

2.15 STEEL PIPE

A. Steel pipe shall be seamless and standard weight Schedule 40 pipe shall conform to ASTM Designation A120 or otherwise noted above. Where indicated on the Drawings to be galvanized (such as pump guide rails or submerged supports), pipe shall be hot-dipped galvanized after fabrication.

B. Joints for pipe 2-in or less shall be threaded for standard screwed joints. Threaded joints shall be made up with good quality thread compound and applied to the male thread only. After having been set up, a joint shall not be backed off unless the joint is completely broken, the threads cleaned and new compound applied. All joints shall be air tight. A sufficient number of unions shall be provided to allow for convenient removal of piping. Unions shall be spaced no more than every 20 ft.

C. Fittings for steel pipe 2-in or less shall be standard malleable iron, 150 lb. Fittings shall conform to ASTM Designation A-47, Grade 32510 service rating. For galvanized pipe, fittings shall also be hot dipped galvanized and shall conform to ASTM Designation A-153. Joints for fittings shall be threaded for standard screwed joints.

D. Where flanged connections are indicated or otherwise required on pipe 2-in or less for connection to flanged valves, fittings, and appurtenances, they shall be made up using companion type flanges. Where flanged fittings are indicated or otherwise required, they shall be made up using threaded steel nipples and steel companion type flanges. Companion flanges shall be steel, 150 lb. ANSI Standard flat face flanges of the threaded type. Flanges shall be spot faced on the back around each bolt hole. For galvanized pipe, flanges shall also be hot-dipped galvanized.

E. Pipe greater than 2-in size, shall have threaded or welded joints. Threaded joints, fittings, and flanges shall be as specified above. Pipe shall have beveled ends for welding. Fittings shall be steel, butt weld type. Standard wall, conforming to ANSI B16.9 and ASTM A234, Grade WPB. Flanges shall be steel slip on or welding neck type, raised face, Class 150, conforming to ASTM A-105 and ANSI B16.5. Gaskets shall be ring type, composition asbestos Sheet No. 3, 1/16-in thick, I.D. and O.D. by pipe size. Bolts and

nuts for flanges shall be hex head cap screws conforming to ANSI B16.2, coarse threads, Class 2A fit, manufactured of ASTM A307, Grade B steel.

F. Steel pipe to be supplied by Tubular USA, Bellmore Steel Products Corp, Tubenet, or approved equal.

2.16 CONCRETE THRUST BLOCKS

A. Concrete thrust blocks strength shall be 3,000 psi and meet, as a minimum the dimensions shown on the Drawings.

2.17 CONCRETE ENCASEMENTS, TANK INFILL AND ANTI-FLOTATION SLABS

A. Concrete strength for encasements, tank infill and anti-flotation slabs shall be 3,000 psi and meet, as a minimum the dimensions shown on the Drawings.

2.18 PLASTIC LINE MARKER TAPE

A. Provide six inch wide by four mil. thick green plastic tape with continuous black printing "CAUTION SEWER LINE BELOW" on one side. Provide tape intended for direct-burial service from one of the following manufacturers or Engineer approved substitute; Allen Systems, Inc., Emed Co. Inc., or Seton Name Plate Corporation.

2.19 PRECAST MANHOLES

A. All sewer manhole structures shall be precast concrete.

B. All precast concrete structures shall conform to ASTM C 478 and shall be similar to those manufactured by Concrete Systems, Inc., Old Castle Precast, Chase Precast, Precast Concrete Sales, Co., Acme Precast, or approved equal. Precast manhole structures shall further conform to the following:

1. Sections shall have tongue and groove joints.
2. Joints between sections shall be made with preformed butyl rubber gaskets conforming to ASTM C 443.
3. Each section shall have no more than two lifting holes or cast-in lifting devices.
4. Precast base shall be manufactured with wall openings to receive the ends of pipes which are to be connected to structure.
5. Pipe openings in base shall be minimum size required to receive pipe, and shall be accurately set to conform to the required line and grade.
6. The minimum inside diameter of all precast manhole structures shall be four (4') feet.

C. Pipe shall be joined to precast base using 4” wide stainless steel Korband and resilient rubber material conforming to ASTM C923 pipe connections. Products to be supplied by Trelleborg, Shaw Pipe, National Pollution Control Systems, or approved equal.

D. Manholes shall have shaped brick inverts.

E. All sewer manholes shall be provided with manhole steps. Manhole steps shall be extruded aluminum, conforming to Fed. Spec. QQ-A-200/8, or polypropylene plastic reinforced with 3/8 in. diameter steel rod.

1. Steps shall be drop-front, anti-skid design, 12 in. wide. Projection of front edge of step shall be greater than or equal to 5 in. from manhole wall.
2. Steps shall be embedded 4 in. into manhole wall. Those portions of aluminum steps to be embedded in manhole wall shall receive a heavy coat of heavy-bodied bituminous paint. Coating shall be thoroughly dry before steps are embedded in manhole.
3. Steps in precast sections shall be embedded at time of casting.

F. Manholes shall be designed to safely withstand an AASHTO H-20 loading, as specified in the AASHTO Specifications.

G. The exterior surfaces of all precast structures shall be given one shop coat of bituminous waterproof coating as manufactured by Kopper Company, Isomat Building Products, Aqual Seal, or an approved equal.

2.20 PRECAST MEMBRANE DRAIN SUMP

Precast concrete structure similar in specifications as 2.25 B, except to include a cast in place hatchway within top slab.

2.21 BRICK

A. Brick for support of cast-iron cover and frame shall be one of the following types:

1. Common brick meeting the physical requirements of ASTM C 62, Grade SW.
2. Clay brick meeting the physical requirements of ASTM C 32, Grade MS.

B. Brick for sewer manhole invert channel shall conform to ASTM C 32, Grade SS.

2.22 PORTLAND CEMENT MORTAR

A. Mortar shall be a Portland cement mortar conforming to ASTM C 270, Type M.

B. Mortar shall contain a waterproofing admixture. Waterproofing admixture shall be one of the following:

Admixture	Manufacturer
Hydratite Plus	W.R. Grace and Company
Medusa Waterproofing	Medusa Portland Cement Co.
Omicron Mortarproofing	Master Builders Company
Mortaron	The Aquabar Company
Hydrocide Powder	Sonneborn Bldg Prod., Inc.

2.23 NONSHRINK GROUT

A. Grout shall be nonshrink cement-based type, such as Master Builders Company "Embeco" or U.S. Grout Corporation "5 Star Grout".

2.24 PRECAST CONCRETE TANKS

A. The concrete tanks for the flow equalization, dosing and treatment process tank shall be as manufactured by Rotondo & Sons, Inc., Old Castle Precast, Chase Precast, Concrete Systems, Inc., Acme Precast, or approved equal. It is critical that the dimensions of the

tanks shown on the contract plans be met as well as location of all hatchway and manhole openings. Internal partitions must be located as shown on the contract drawings.

B. The precast tanks shall include the following:

1. Precast 19,000 gallon Concrete Partitioned Pre Anoxic Zone Aeration Zone and Post Anoxic Tank
2. Precast Concrete Dosing Tank
3. Precast Membrane Drain Sump
4. Precast Concrete Denite Sump

C. Precast concrete structures shall further conform to the following:

1. The tank structural design shall be based on groundwater being at the elevation of the ground surface. The structural design of each unit shall take full account of the load applied by the soil and structure(s) to be placed above the unit as well as H-20 vehicle loading.
2. All sections shall have tongue and groove joints.
3. Joints between sections shall be made with preformed rubber gaskets conforming to ASTM C 443.
4. Each section shall have cast-in lifting devices (NO HOLES WILL BE ALLOWED).
5. The tanks will be provided with copolymer manhole steps at intervals of not more than twelve (12") inches on the wall where the main access cover is located.
6. The tanks shall be manufactured with wall openings to receive the ends of pipes, which are to be connected to structure.
7. Pipe openings in the tanks shall be minimum size required to receive pipe, and shall be accurately set to conform to the required line and grade.
8. Entrance and discharge pipes shall be joined to tanks using "KOR-N-SEAL" pipe connections.
9. The exterior surfaces of all precast structures shall be given two shop coats of bituminous waterproof coating.
10. The installed tanks must be leak tested by the tank supplier after installation as specified herein and the supplier shall provide a written certification that each Precast Concrete Tank specified is watertight.

2.25 CASTINGS

A. Manhole frames and covers shall be cast iron conforming to ASTM A 48, Class 35, and Massachusetts Highway Department Standard Details. Frames and covers shall be suitable for AASHTO H-20 loading.

1. All 24" manhole frames and covers shown on the drawings shall have a 24" diameter (clear opening) and shall be Catalog #LB268-3 as manufactured by Ease Jordan Iron Works, Neenah Foundry co., Mechanic Iron Foundry, or approved equal. The manhole frames and covers shall provide for a 24" clear opening.

2. All sewer and tank/structure manhole covers shall read "SEWER".

3. All approved equals for the castings specified shall be North American made, heavy-duty castings.

B. Castings shall have shop-applied coal-tar-pitch varnish coating.

2.26 TANK ACCESS COVER/HATCHWAY

A. The hatchway for the Flow Equalization Tank, Dosing Tank shall be a heavy-duty style, H-20 loading, aluminum hatchway (Model #ECD-13HD (36"x 60" size) as manufactured by Syracuse Casting, Bilco Hatchways, Halliday, Babcock Davis, or approved equal.

B. The Hatchway for the precast pre Anoxic, Aeration and Post Anoxic Tanks located inside the WWTP building shall be sized as shown on drawings except they may be H-10 loading (safety grate required). Membrane drain sump, denite sump, shall be same manufacturer as A above except hatchway shall be 24” x 30” size and may be H-10 loading rating with safety gate.

C. Hatchway material shall be 6061-T6 aluminum for bars, angles and extrusions. 1/4” diamond plate shall be 5086 aluminum. Hatchway design of each access hatch shall conform to OSHA standard 1910.23. The hatchway unit shall be designed heavy duty, for H-20 wheel loads, where not subject to high density traffic. Angle frame and bearing plate must be cast into and supported by concrete. Each hatch shall be designed using a maximum design stress of 17,300 psi as per the Aluminum Association, Inc. “Specifications for Aluminum Structures”, with a safety factor of 2.2 applied to a minimum allowable tensile strength. Engineering calculations shall be supplied upon request.

D. Each hatchway door shall be supplied with a heavy duty, stainless steel pneu-spring, for ease of operation when opening cover. Cover shall be counterbalanced, so one person can easily open the hatch door. Spring design shall accommodate ease of maintenance. Each door shall be equipped with a grade 316 stainless steel hold open arm. Door shall lock open in the 90 degree position. Each hold open arm shall have a red vinyl grip handle. Hold open arm shall be fastened to the frame with a ½” grade 316 stainless steel bolt.

E. The hatchway angle frame shall be of extruded aluminum, with a continuous 1-1/2” anchor flange. Angle frame shall be a minimum of 1/4” thick. Hinges shall be of heavy duty design. Material shall be a brass alloy with a 65,000 psi tensile strength. Each hinge shall have a 3/8” grade 316 stainless steel pin. Hinges shall be bolted to the angle frame and diamond plate, with grade 316 stainless steel bolts and ny-lock nuts.

F. Each hatch shall be supplied with a grade 316 stainless steel slam lock, with keyway protected by a threaded aluminum plug. Plug shall be flush with the top of the 1/4” diamond plate. Slam lock shall be fastened with four grade 316 stainless steel bolts and washers. Each hatch shall be equipped with an aluminum lift handle. The lift handle shall be flush with the top of the 1/4” diamond plate.

G. The hatchway shall be provided with safety grates as manufactured for ITT Flygt Corp. Safety grates shall be made of 6061-T6 aluminum with a minimum ultimate strength of 38,000 psi and a minimum yield strength of 35,000 psi, as per ASTM B221. Grate design shall use safety factors as defined in the “Specifications for Aluminum Structures”, by the aluminum Association, Inc., 5th edition, Dec. 1986 for “Bridge Type Structures”.

H. Grating for outside tankage shall be designed to withstand a minimum live load of 300 pounds per square foot. Deflection shall not exceed 1/150th of the span. Grate opening shall be 5” x 5”, which will allow for visual inspection of the pit, once the access hatch is open. Each grate shall be provided with a permanent hinging system, which will lock the grate in the 90 degree position once opened. Each grate shall have an opening arm, with

a red vinyl grip handle, which will allow opening of the grate, while providing the grate as a barrier between the operator and the pit.

I. Grate shall be painted with OSHA type safety orange paint. Welding shall be in accordance with ANSI/AWS D1.2-90 Structural Welding Code for Aluminum.

2.27 VALVES AND VALVE BOXES

A. Gate valves shall be iron body, resilient seated, tight-closing type. The valves shall be designed for minimum of 200 psi working pressure and 400 psi test pressure meeting all requirements of the latest AWWA Specification C509. Valves shall have a 10-mil minimum thickness factory applied epoxy coating on the interior and exterior surfaces. Epoxy coating shall be suitable for potable water usage and certified to NSF 61 standards the latest AWWA Specification C550.

B. Valves are to have O-ring seals and a non-rising bronze stem. Valves shall have a 2-inch operating nut. Valves shall open left.

C. Resilient wedge valves shall meet or exceed the most recent version of the AWWA standard specification for gate valves C-509-87.

D. Valves shall be AVK Resilient Seat Gate Valve, U.S. Pipe, Mueller, Watts, or approved equal. All valves shall be U. L. listed and approved by Factory Mutual for fire service.

E. Valve boxes shall be cast iron, tar coated, sliding, heavy pattern type, consisting of three (3) pieces; a flanged bottom piece (oval in shape and compatible to the valve size), a flanged top piece, and a cover with two (2) lifting holes. Valve boxes shall further conform to the following:

1. Box shall be designed and constructed to prevent the direct transmission of traffic loads to the piping or valve.
2. Upper section of box shall have a flange with sufficient bearing area to prevent undue settlement. Lower section of box shall be designed to enclose the valve operating nut and stuffing box, and rest on the backfill.
3. Boxes shall be adjustable by 6 in. vertically without reduction of the lap between sections to less than 4 in.
4. Inside diameter shall be 6" for all gate valves. The sliding top section shall be 26" long, extra heavy duty. The bottom section shall be 5-1/4" inside diameter by 60" long with bell.
5. Box cover shall be close fitting and substantially dirt tight. Top of cover shall be flush with top of box rim. Cover shall have the word "SEWER" cast into the top. Valve boxes shall be supplied by Trumball Industries, D&L Supply, Sigma Co., or approved equal.

2.28 CHECK VALVES

A. Provide VB Series ball check valves at all locations shown on drawings. Check valve to be manufactured by IPEX, Flomatic Corp, Crispin Multiplex Mfg., or approved equal.

2.29 BITUMINOUS PAINT

A. Bituminous paint shall be Koppers Company, Inc., Isomat Building Products, Aqualseal or equivalent bituminous-base product.

2.30 ASPHALT MASTIC CEMENT

A. Asphalt mastic cement shall be a pitch-base or asphalt-base compound fibrated with non-asbestos fibers conforming to Fed. Spec. SS-C-153, as supplied by FBC Chemical Corp., Hamilton Kent-Kern Seal, Stone Technologies, or approved equal.

2.31 EMBEDMENT MATERIALS

A. All sewer pipe, forcemain pipe and precast concrete structures shall be installed on a bed of and surrounded by gravel fill as shown on the Drawings. Gravel fill and sand fill shall conform to the requirements of Section 3120000, EARTH MOVING.

2.32 PAVEMENT REPAIR AND PATCHING MATERIALS

A. Materials for pavement patching and repair (temporary and permanent) shall conform to Section 32 10 00, BASIS, BALLAST, AND PAVING of these specifications.

PART 3 - EXECUTION

3.1 TEST PITS

A. Prior to ordering any materials or utility structures for the project, the Contractor shall excavate test pits to determine the exact locations and elevations of all existing utilities at critical points such as at every location where a proposed utility line is to cross an existing utility line and at every point where a proposed utility line is to connect with an existing utility line.

B. The Engineer shall be notified at least five days in advance of any test pit excavation. Such notice shall include a sketch of the proposed test pit locations.

C. Work on the test pits shall proceed slowly, with the Engineer or the Owner's Representative present and a representative of the Town of Plymouth Board of Health or the appropriate utility company. Hand excavation shall be required when the excavation nears the utility line.

D. Test pit excavation and backfill shall conform fully with the relevant portions of these specifications.

E. Test pit surface restoration shall conform fully with the relevant portions of these specifications for paving, walkways, curbing and all lawn areas.

3.2 RECORDING OF TEST PIT INFORMATION

A. The Contractor shall keep a precise record of all information uncovered by test pit excavation including soil types encountered and the elevations of all changes in soil strata and the size, type, material, location and elevation of any utility lines encountered. The Contractor's surveyor shall locate all test pits and utility lines and obtain elevations on the ground surface, the bottom of the test pit and any utility lines encountered.

B. All information uncovered by test pit excavation shall be incorporated into the Project Record Drawings and incorporated into the As-Built Plans.

C. The Contractor shall immediately report any discrepancies in utility locations or elevations discovered as a result of his test pit operations, in writing, to the Engineer and the Owner.

3.3 PIPE STUB MARKERS

A. The Contractor shall install pipe stub markers at the ends of all buried pipe ends uncovered by the test pit operations.

3.4 TIES

A. The Contractor shall take ties and top of pipe elevations at all underground utility lines uncovered by the test pit excavation to permit the accurate location of the utility line after backfilling. Ties shall be to permanent physical points which may be accurately reproduced.

B. The Contractor shall review the location of all tie points with the Engineer prior to backfilling the test pit.

3.5 PROTECTION OF EXISTING STRUCTURES AND UTILITIES

A. Existing structures and utilities shall be suitably protected from damage, including but not limited to existing stone walls, brick walls, pavements, walks, manholes, sewer lines, drain lines, water lines and utility lines.

3.6 GENERAL

A. It is not intended that the Drawings shall show the exact locations of every utility, but the Contractor shall coordinate with all other utilities as necessary to complete the system in accordance with the best trade practice, to the satisfaction of the Engineer and all authorities having jurisdiction.

B. Obtain detailed information from the manufacturers of apparatus as to the proper method of installing and connecting same.

C. Carefully store materials and equipment which are not immediately installed after delivery to site. Close open ends of work with temporary covers or plug during construction to prevent entry of obstructing material.

D. All existing utilities shall be verified for service, size, invert elevations, location, prior to new connections to or relocation of same. Notify the Engineer in writing of any and all discrepancies prior to commencing any work. All existing utilities uncovered during excavations and construction, not indicated on the plans, shall be plugged, capped, rerouted or relocated as directed by the Engineer so as not to interrupt the operation of any of the existing systems. No claims for extra compensation will be recognized if difficulties are encountered which an examination of site conditions and Contract Documents prior to executing the Contract would have revealed.

E. All disruption of service required for execution of work within this section shall be coordinated with affected parties, on both the beginning time and the duration of the

disruption of service. Existing operations may require "off hour" and minimum disruption period.

3.7 HANDLING AND CUTTING PIPE

A. The Contractor's attention is directed to the fact that in cold weather PVC pipe and fittings are brittle. Every care shall be taken in handling and laying pipe and fittings to avoid damaging the pipe, scratching or marring machined surfaces and abrasion of the pipe coating or lining. Joint ends of pipe shall especially shall be kept clean.

B. Pipe shall be stored above ground at a height no greater than 5 feet, and with even support for the pipe barrel.

C. Only nylon-protected slings shall be used for handling the pipe. No hooks or bare cables will be permitted.

D. Gaskets shall be shipped in cartons and stored in a clean area, away from grease, oil, heat, direct sunlight and ozone producing electric motors.

E. Any fitting showing a crack and any fitting or pipe which has received a severe blow that may have caused an incipient fracture, even though no such fracture can be seen, shall be marked as rejected and removed at one from the work.

F. In any pipe showing a distinct crack and in which it is believed there is no incipient fracture beyond the limits of the visible crack, the cracked portions, if so approved, may be cut off by and at the expense of the Contractor before the pipe is laid so that the pipe used will be perfectly sound. The cut shall be made in the sound barrel at a point at least 12 in. from the visible limits of the crack.

G. Except as otherwise approved, all cutting shall be done with a machine suitable for cutting PVC pipe. Hydraulic squeeze cutters are not acceptable for cutting pipe. Travel type cutters and guillotine or rotary type abrasive saws may be used. All cut ends shall be examined for possible cracks caused by cutting. The method of cutting used shall leave a smooth cut at right angles to the axis of the pipe.

H. The Contractor's attention is directed to the fact that damage to the lining of pipe or fittings will render them unfit for use; he shall use the utmost care in handling and installing lined and coated pipe and fittings to prevent damage. Protective guards shall not be removed until the pipe is to be installed.

I. Any damage to the exterior coating of pipe or fittings shall be repaired as directed by the Engineer.

3.8 PIPE INSTALLATION

A. Piping shall be installed essentially as indicated on the Drawings. Where exact locating dimensions of piping are not given on the Drawings, the Engineer's approval shall be obtained for proposed locations before installation. Unless otherwise shown on the Drawings, all pressure pipes shall be buried with a minimum four foot cover. It may be necessary at utility crossings to install pressure lines deeper to avoid those utilities. The lower installation will not be considered as an extra cost to the project.

B. All PVC pipe and fittings shall be installed in accordance with the manufacturer's recommendations and the following:

1. Inspect pipe before installation to detect any apparent defects. Mark defective material with white paint and promptly remove from the site. All pipe and fittings shall be thoroughly cleaned before laying, shall be kept clean until they are used in the work and when laid shall conform to the lines and grades required. A firm bed, even bearing throughout the length of the pipe, shall be constructed by tamping selected material at the sides of the pipe up to mid-section. Blocking will not be permitted.
2 All pipes shall be sound and clean before laying. Bottom of trench excavation shall be kept dry and free of water during pipe installation. Adequate measures shall be taken to prevent flotation of pipe in the trench. When laying is not in progress, including lunch time, the open ends of the pipe shall be closed by watertight plug or other approved means.
3. Pipe shall be laid with the groove or bell end upstream. Bell shall rest over a shallow excavation in pipe bedding to prevent pipe weight from bearing on bell.
4. Each pipe length shall be installed in good alignment (both horizontally and vertically) to form a close joint with the next adjoining length and bring inverts to the required grade.
5. Joint deflection for all piping shall not exceed that recommended by the manufacturer. Additional fittings shall be supplied by the Contractor as necessary or to maintain the horizontal and vertical alignment or to cross existing or proposed utilities. All such fittings shall be considered incidental to the installation of the pipe and shall be installed at no additional cost to the Owner.
6. Each pipe length shall have a firm bearing along its entire length. Pipe bedding material shall be shaped to receive the pipe. No pipe or fitting shall be permanently supported on saddles, blocking, or stones.
7. Pipe shall be laid to proper grades, free from pockets.
8. Pipe shall be thoroughly cleaned before installation, and shall be maintained free from foreign matter during installation.
9. Tight-fitting temporary wood bulkheads or plugs shall be employed to close ends of pipeline immediately after installation.
10. Pipe shall not be backfilled until joints have been fully inspected, and approved.
11. Entire length of pipe shall be thoroughly flushed clean following completion of backfill.
12. Jointing of push-on pipe and fittings shall be done in accordance with the printed recommendations of the manufacturer and as specified. The last 8-inches of the outside of the spigot end of pipe and the inside of the bell end of pipe shall be thoroughly cleaned. The joint surfaces and the gasket shall be painted with a lubricant just prior to making up the joint. The spigot end shall then be gently pushed home into the bell. The position of the gasket shall be checked to insure that the joint has been properly made and is watertight. Care shall be taken not to exceed the manufacturer's recommended maximum deflection allowed for each joint.
13. Pipe joints shall be made with rubber gaskets.
    a. Rubber gasketed joint: Pipe gasket shall be installed using lubricants, cements, adhesives, and other accessories and methods recommended by the gasket manufacturer. Pipe and gasket surfaces shall be kept clean until pipe has been properly drawn up and the joint closed. Gaskets and other jointing material shall be placed on the pipe

immediately before joint is made up. Jointing materials shall be inspected and defects repaired before joint is completed.

14. Any pipe which is found defective after having been laid shall be removed and replaced with a sound piece of pipe at no additional cost to the Owner.
15. Piping in the precast concrete tanks and pump chambers shall be installed under this section of the specifications but shall be supported in accordance with the pipe support requirements of the specifications.
16. All fittings shall be laid and jointed to assure a water tight connection and proper alignment. Fittings shall be lowered into the trench, inspected and cleaned of all dirt and debris. All plugs, caps, tees and bends shall be provided with a concrete thrust block to solid ground as shown on the Drawings.

C. Pipe shall be thoroughly cleaned before installation, and shall be maintained free from foreign matter during installation.

1. When pipe laying is stopped for <u>any</u> length of time, including short periods, the open ends of the pipe and fittings shall be closed with a watertight plug or cap.
2. Entire length of pipe shall be thoroughly flushed clean following completion of backfill.

D. The electrical conduits in the precast concrete pump station tank shall be vapor sealed at both ends to prevent vapors from the tank(s) from entering the conduit(s).

E. Joint Restraints

1. Changes in direction, both vertical and horizontal, tees. plugs, caps and tapping sleeves shall be restrained with concrete thrust blocks.
2. Concrete for thrust blocks shall be of the minimum size specified on the Drawings and shall meet the requirements of the specifications. Felt roofing paper shall be placed to protect pipe joints before placing the concrete. Concrete shall not be placed over bolts or nuts, or in a manner which prevents the removal of the joints.

F. Any pipe which is found defective after having been laid shall be removed and replaced with a sound piece of pipe at no additional cost to the Owner.

G. Valves: Prior to lowering the valves into the trench, they shall be cleaned of dirt and debris and operate to the satisfaction of the Engineer. Gate valves shall be set on firm foundations of undisturbed earth or masonry in a horizontal and plumb position. Piping into and out of the valve shall not exceed a length of six feet before the next pipe joint. When backfilling about the valve, care shall be taken not to disturb its set position. Upon backfilling to a point two inches or more above the flanged joints of the valve cover, the back base shall be set. Valve boxes shall be set in a plumb position with the cover flush with the finished grades. When placing the backfill about the boxes, care shall be taken to assure the unit's plumbness.

3.9 ASSEMBLING SLEEVE-TYPE COUPLINGS

A. Sleeve-type couplings shall be used only where approved by the Engineer.

B. Prior to the installation of sleeve-type couplings, the pipe ends shall be cleaned thoroughly for a distance of 8 in. Soapy water may be used as a gasket lubricant. A follower and gasket, in that order, shall be slipped over each pipe to a distance of about 6

in. from the end, and the middle ring shall be placed on the already laid pipe and until it is properly centered over the joint. The other pipe end shall be inserted into the middle ring and brought to proper position in relation to the pipe already laid. The gaskets and followers shall then be pressed evenly and firmly into the middle ring flares.

C. After the bolts have been inserted and all nuts have been made up fingertight, diametrically opposite nuts shall be progressively and uniformly tightened all around the joint, preferably by use of a torque wrench of the appropriate size and torque for the bolts.

D. The correct torque as indicated by a torque wrench shall not exceed 90 ft.-lb.

3.10 PRECAST MANHOLE INSTALLATION

A. Manholes shall be set to the required elevation and shall be plumb and vertical, with each section in true alignment.

1. Lifting holes in precast sections shall be thoroughly plugged with mortar and finished smooth and flush with adjoining surfaces.
2. Sewer pipe shall extend, around its entire circumference, to inside surface of wall of structure into which it is inserted. Pipe shall be joined to manhole wall using the attached resilient rubber connector boot. The boot shall be sealed to the pipe using the stainless steel bands supplied with the boot.
3. The gap between the resilient rubber connector boot and the pipe on the inside of the manhole structure shall be filled using nonshrink grout.

B. The Contractor shall provide brick to bring all new and existing manhole cast iron frames and covers to required finish elevation. In paved areas the rims shall not be finally adjusted until the binder course paving is placed. Completed brick installation shall be coated with at least a 3/4 in. thickness of mortar on outside to provide sealed watertight collar between top manhole or catch basin section and cover or grate frame.

1. Before installation of castings, touch up chipped and scraped areas with one coat of bituminous paint.
2. Cast iron frame shall be set concentric with manhole opening in a full bed of mortar. A thick ring of mortar extending to the outer edge of brick or concrete shall be placed all around the bottom flange of the cast iron frame. Mortar surface shall be smooth and shall be sloped to shed water away from the frame.
3. Waterproofing shall be added to the mortar for underground masonry in accordance with the waterproofing manufacturer's directions. Other additives will not be permitted in the mortar.

C. Portland cement-based mixtures used on this work shall receive a minimum of three days of moist curing, which shall start immediately after the material has been placed. Suitable means shall be employed to protect cement-based mixtures from too rapid drying and damage from cold weather and frost.

D. All rims in paved areas shall be encased in concrete collars as shown on the details on the Drawings.

E. Where required, connect new piping to existing manholes and catch basins by cutting or breaking into existing structures. Patch and finish with nonshrink grout to Engineer's satisfaction.

3.11 PRECAST CONCRETE TANK INSTALLATION

A. All precast concrete tanks and structures shall be installed in the locations shown on the Drawings, true to line and grade, level and plumb. Precast concrete tanks shall include supervised installation and provide written water tight certification.

B. The contractor must meet the following requirements for the installation of the precast tanks and structures to be certified watertight:

1. The precast unit(s) must be placed on a base of 12 inches (minimum) of compacted gravel fill. The gravel base must be transit leveled and be suitably compacted to support the unit(s) without the chance of differential settlement.
2. The excavation must be pumped dry during the installation.
3. The unit(s) must be backfilled within 24 hours of the installation starting with the two ends in order to properly compress the joining gaskets, then working to the two long walls.
4. The crane (provided by the Contractor) must be large enough to place the unit(s) without damaging them in any way.
5. Suitable backfill material and placement methods must be used to avoid any damage or shifting of the units.
6. The joints must be clean of any foreign material while the units are being drawn together.
7. Tank must be backfilled prior to filling (water testing) to prevent potential joint separation.
8. Tank manufacturer is responsible for supervision of the tank installation. It is the responsibility of the Contractor to provide the necessary manpower to do the work involved in setting the tank.

C. All tank penetrations shall be sealed watertight inside and outside with non-shrink waterproof grout. Upon completion of the installation of the tank by the contractor under the supervision of the tank manufacturer, the tank manufacturer shall provide the Owner and the Contractor with signed, certified copies of the watertight guarantee for the tanks after the tanks have been tested. **(CRITICAL)**

D. It shall be the responsibility of the contractor to take suitable measures to prevent flotation of the tank until all of the backfill has been placed on top of the tank and all anti-flotation slabs and/or concrete infill have been placed.

E. All precast concrete tanks shall each be tested for leakage as specified. Leakage shall be less than 1% of tank volume over 24 hours. **(CRITICAL)**

3.12 CONCRETE THRUST BLOCKS AND ENCASEMENTS

A. Concrete Thrust Blocks: Install at all fittings and plugged ends on pressure pipelines and as indicated on the Drawings. Prior to pouring concrete, pipe and fittings shall be covered with polyethylene to prevent concrete from bonding to pipe and fittings. The concrete backing shall be poured directly against undisturbed earth and shall consist of concrete having strength at least 3,000 psi in 28 days.

B. Concrete Encasements: Install where required due to utility clearance or cover conditions as indicated on the Drawings. Prior to pouring concrete, pipe and fittings shall

be covered with polyethylene to prevent concrete from bonding to pipe and fittings. The concrete backing shall be poured directly against undisturbed earth and shall consist of concrete having strength at least 3,000 psi in 28 days.

C. Concrete Tank Infill: Install where indicated on the Drawings. The concrete shall be poured using forms to control the placement and shall consist of concrete having strength at least 3,000 psi in 28 days.

3.13 PIPE INSPECTION

A. Interior Inspection: Inspect pipe to determine whether line displacement or other damage has occurred.

1. If the inspection indicates poor alignment, debris, displaced pipe, infiltration or other defects, correct such defects to satisfaction of the Engineer.

3.14 PIPE CLEANING

A. Cleaning Pipe: Clean interior of pipe of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed.

1. Flush lines to remove collected debris before connecting to other wastewater piping, treatment system or tankage. Flush pipe at rates of flow recommended by the Engineer.

3.15 TESTING

A. The entire sewer system, including piping, manholes, tanks and structures shall be tested for leakage. The gravity system may be tested by the use of either water or low-pressure air. Manholes and tight tanks shall be tested using a vacuum. Other tanks and precast concrete structures shall be tested by using water. Forcemain and other pressure piping shall be tested by the use of water.

B. General test requirements.

1. Piping shall be adequately restrained against movement before testing. All force main piping shall have thrust blocks installed and the concrete shall have attained full strength before test pressure is applied to the line.
2. Piping system shall be flushed clean, and sediment, scale, dirt, and debris removed before piping is tested.
3. Adequate provisions shall be made for carrying off flushing water without causing erosion or other damage.
4. Manholes and piping shall be tested before joints are concealed or made inaccessible.
5. Tests shall be made in the presence of the Engineer and an inspector from the Town of Plymouth Board of Health and the Commonwealth of Massachusetts, Department of Environmental Protection, Division of Water Pollution Control.

C. Notice of tests shall be made in writing to the Engineer and the Town of Plymouth Board of Health and the Commonwealth of Massachusetts, Department of Environmental Protection, Division of Water Pollution Control. Such notices shall be mail sufficiently in advance of the testing so that all parties receive the notice not less than five (5) days before the date of test.

D. Gravity flow system test.

1. When the groundwater is more than 1 ft. above the crown of the pipe at the upper end of the section to be tested, an infiltration test shall be made. The upper end of the section to be tested shall be plugged and a V-notch weir of appropriate size shall be fitted into the lower end. There shall be no leakage around the weir plate. Commercially manufactured weirs, made and calibrated for the purpose, may be employed.
2. When groundwater is less than 1 ft. above the crown of the pipe at the upper end of the section to be tested, an exfiltration test shall be made. The sewer shall be plugged at the inlet pipes of both the upper and lower manholes. The line shall then be filled with water to a level 2 ft. above the crown of the pipe in the upper manhole. Before any measurements are made, a period of about 2 hours shall be permitted to allow for absorption and escape of trapped air. Following this, a test period of at least 2 hours shall begin. At the end of the test period, loss of water shall be measured and leakage computed therefrom.
3. Air testing shall be performed in accordance with the procedures described in ASTM C 828, except as otherwise noted. For low-pressure air tests use equipment specifically designed and manufactured to test sewer pipelines with low-pressure air. The equipment shall be provided with an air regulator valve or air safety valve so set that the internal air pressure in the pipeline cannot exceed 8 psig.
   a. The leakage test using low-pressure air shall be made on each manhole-to-manhole section of pipeline after placement of the backfill.
   b. Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be tested. Pneumatic plugs shall resist internal test pressures without requiring external bracing or blocking.
   c. All air used for testing shall pass through a single control panel.
   d. Low-pressure air shall be introduced into the sealed line until the internal air pressure reaches a value 4 psig greater than the maximum pressure exerted by groundwater that may be above the invert of the pipe at the time of test. However, the internal air pressure in the sealed line shall not be allowed to exceed 8 psig. When the maximum pressure exerted by the groundwater is greater than 4 psig, conduct infiltration test.
   e. At least two minutes shall be allowed for the air pressure to stabilize in the section under test. After the stabilization period, the low-pressure air supply hose shall be quickly disconnected from the control panel. The time required in minutes for the pressure in the section under test to decrease from 3.5 to 2.5 psig (greater than the maximum pressure exerted by groundwater that may be above the invert of the pipe) shall not be less than that shown in the following table:

Pipe diameter in inches	Minutes
4	2.0
6	3.0
8	4.0
10	5.0
12	5.5
15	7.5
18	8.5
21	10.0

24	11.5

f. When the sewer section to be tested contains more than one size of pipe, the minimum allowable time shall be based on the largest diameter pipe in the section, and shall be the time shown in the table reduced by 0.5 minutes.

4. Rate of infiltration and exfiltration shall not exceed 100 gal./in. of pipe diameter per mile of pipe per 24 hours. Each section of pipe tested shall meet the above criterion.
5. If section shall fail to pass leakage test, locate, uncover, and repair or replace defective pipes, fittings, or joints, without extension of time for completion of work and at no additional cost to the Owner. Additional tests and repairs shall be made until section passes specified tests.

E. Manhole, tank and structure testing.

1. Leakage testing of sewer manholes shall be included in the testing of the wastewater treatment system. Leakage for each manhole shall not exceed 1 gal./vertical ft. of manhole per 48 hours.
2. Leakage testing of all precast concrete structures shall be done using water. Leakage for each precast tank shall not exceed 1% of the tank or structure volume in 24 hours.

3. If any manhole, tank or precast concrete structure shall fail to pass leakage test, repair or replace defective sections or joints without extension of time for completion of work and at no additional cost to the Owner. Additional tests and repairs shall be made until the manhole, tank or precast structure passes the specified tests.

F. Forcemain Testing:

1. All portions of sewer force main from the Dosing Tank to the existing Leach Area (Distribution Box) shall be tested for leakage. System shall be tested by use of water.
2. General test requirements.
   a. Piping shall be adequately restrained against movement before testing. Pressure line shall have thrust blocks installed and concrete shall have attained full design strength before test pressure is applied to line.
   b. Piping system shall be flushed clean, and sediment, scale, dirt, and debris removed before piping is tested.
   c. Adequate provision shall be made for carrying off flushing water without causing erosion or other damage.
   d. Piping shall be tested before joints are concealed or made inaccessible. Piping shall have no visible leakage.
   e. Tests shall be made in presence of the Owner, the Engineer and an inspector from the Town of Plymouth Board of Health and MA DEP.
3. Notice of tests shall be made in writing to the Owner, the Engineer and Town of Plymouth Board of Health and MA DEP and received by them at least five (5) days before date of test.
4. Forcemain Pressure and Leakage Tests:
   a. Pressure pipe shall be given combined pressure and leakage tests in sections of acceptable length.

b. Furnish and install suitable temporary testing plugs or caps; all necessary pressure pumps, pipe connections, meters, gages, and other necessary equipment; and all labor required.

c. Unless it has already been done, section of pipe to be tested shall be filled with water of approved quality, and all air shall be expelled from pipe. Provide blow offs at high point (air release) to allow trapped air to escape.

d. Section under test shall be maintained full of water for a period of 1 hour prior to combined pressure and leakage test being applied.

e. Meter and gauge shall be installed and shall be kept in use during test so that water entering water main under test will be measured and pressure in water main indicated.

f. Pressure test shall consist of first raising water pressure (based on elevation of lowest point of section under test and corrected to gage location) to a pressure of 50 lb. per sq. in. If Contractor cannot achieve specified pressure and maintain it for a period of one hour with no additional pumping, section shall be considered as having failed to pass test.

g. If section shall fail to pass pressure test, leakage test, or both, locate, uncover, and repair or replace defective pipes, fittings, or joints, without extension of time for completion of work. Additional tests and repairs shall be made until section passes specified tests.

h. All joints within vaults shall have no visible leakage. Joints from which water continues to run or squirt in an active manner will not be accepted.

i. Upon successful completion of tests, plugs or caps installed for testing shall be removed.

j. If, in judgment of Engineer, it is impractical to follow foregoing procedure exactly for any reason, modifications in procedure can be made by the engineer, but in any event Contractor shall be responsible for tightness of line within above leakage and pressure requirements.

G. Before submitting system for final approval of the authorities having jurisdiction, submit a written statement to Engineer that work has been completed in accordance with the Contract Documents.

H. Any portion of the sanitary sewerage system which is found not to be in compliance with the Drawings and specifications shall be replaced by the Contractor in conformance with the Drawings and specifications at no cost to the Owner.

I. Promptly following satisfactory completion of leakage testing, a report fully describing test procedures and listing test results shall be submitted to the Engineer and to governmental agencies that have jurisdiction. The report shall be signed by the Contractor's superintendent.

3.16 INSPECTIONS AND APPROVALS

A. The Contractor shall notify and make all necessary arrangements with the Town of Plymouth Board of Health and the Commonwealth of Massachusetts, Department of Environmental Protection, Division of Water Pollution Control sufficiently in advance of the installation of the sanitary sewerage system for any testing and inspection to occur.

B. The Contractor shall be responsible for making all arrangements with the Town of Plymouth Board of Health and the Commonwealth of Massachusetts, Department of

Environmental Protection, Division of Water Pollution Control and for paying all fees associated with the sanitary sewerage system installation, testing and inspection.

C. Any work installed without the proper inspections shall be removed and reinstalled with the proper inspections at no cost to the Owner.

D. Any work failing to pass inspection shall be repaired or removed and replaced until it passes inspection at no additional cost to the Owner.

E. The following is the minimum schedule of inspections:

1. An inspection shall be scheduled after the tankage and piping between the tanks has been installed but prior to backfilling.
2. Provide inspections (biweekly to weekly) to observe installation of all BIOPROCESS treatment equipment and piping within the WWTP building.
3. Final inspections (dry test and wet test) of the entire new waste treatment construction shall be requested when all work is complete and water and power is available to conduct the inspection. Dosing pumps must be operational with permanent electrical connection. **(CRITICAL)** The Contractor shall have his As-Built plans of the wastewater treatment system, pumps and controls available for review at the time of this inspection. The wet test shall coincide with the startup of the wastewater pumps and controls.

F. Additional or repeat inspections may be necessary depending on the quality of the work and any necessary corrections to defective work.

3.17 MAINTENANCE OF EXISTING FLOW

A. The Contractor shall schedule his work so as to maintain sewage flow within the existing wastewater treatment system until the new sewer collection and treatment systems have been fully tested, accepted and approved for operation.

3.18 MANHOLE AND TANK/STRUCTURE RIM, HATCHWAY AND VALVE BOX ADJUSTMENTS

A. The Contractor shall provide brick to bring all new and existing manhole cast iron frames, covers, and grates to required finish elevation. In paved areas the rims shall not be finally adjusted until the binder course paving is placed. Completed brick installation shall be coated with at least a 3/4 in. thickness of mortar on outside to provide sealed watertight collar between top manhole section and cover or grate frame.

1. Before installation of castings, touch up chipped and scraped areas with one coat of bituminous paint.
2. Frame shall be set concentric with manhole or catch basin opening in a full bed of mortar. A thick ring of mortar extending to the outer edge of brick or concrete shall be placed all around the bottom flange of the cast iron frame. Mortar surface shall be smooth and shall be sloped to shed water away from the frame.
3. Waterproofing shall be added to the mortar for underground masonry in accordance with the waterproofing manufacturer's directions. Other additives will not be permitted in the mortar.

B. Portland cement-based mixtures used on this work shall receive a minimum of three days of moist curing, which shall start immediately after the material has been placed.

Suitable means shall be employed to protect cement-based mixtures from too rapid drying and damage from cold weather and frost.

C. The Contractor shall adjust all new and existing sewer gate and curb boxes to required finish elevation. In paved areas the castings shall not be finally adjusted until the binder course paving is placed.

D. All castings in paved areas shall be encased in concrete collars as shown on the details on the Drawings.

3.19 DECOMMISSIONING OF EXISTING WWTP EQUIPMENT LOCATED INSIDE EXISTING WWTP BUILDING

A. Before beginning any decommissioning work, disconnect or arrange for the disconnection of all utility service lines to any equipment or tanks to be decommissioned. Notify the proper local authorities and utility companies, in writing before work commences. Remove all utility and service lines in accordance with the authorities and/or companies having jurisdiction over such work. Identify the location and size of all caps and plugs to the Engineer in writing. Notify MA DEP of decommissioning schedule.

B. Take all possible precautions to avoid damaging all equipment which are to remain.

C. Decommissioning work shall be carried out in a careful and orderly manner. Provide adequate protection to persons and property inside and outside of the site. All existing Tanks, Pump Chambers and Sand Filters shall be pumped of all sewage and Media, power washed and disinfected per MA DEP requirements.

D. Dispose of material or debris on the site.

E. Take all possible precautions to avoid damaging those materials which are to be salvaged.

F. Remove and legally dispose of, at no cost to the Owner, all materials and debris resulting from decommissioning work except those items scheduled for salvaging or stockpiling. Disposal shall be timely, performed as promptly as possible and not left until the final clean up.

G. Leave the interior of the existing WWTP building in a safe and clean condition at the completion of the decommissioning work.

H. THE REUSE OF EXISTING MANHOLES OR FRAMES AND COVERS ON PORTIONS OF THE NEW WORK ON THE PROJECT WILL NOT BE ALLOWED.

3.20 DEMOLITION OF SELECTED EXISTING EXTERIOR SLUDGE STORAGE TANKS (AS SHOWN ON CONTRACT DRAWINGS)

A. Demolition of existing exterior sludge tank serving the existing WWTP as shown on Contract Drawings, not to be demolished until new WWTP is placed in service.

B. Exterior existing tank shown on Contract Drawings to be demolished, to be crushed and filled with select compacted gravel. All contents to be pumped and removed off site to legal licensed DEP approved Septage Receiving Station.

C. Surface in area of demolished tank to be repaired to equal or better than the existing surface conditions.

3.21 SANITARY SEWERAGE SYSTEM TIES

A. During the installation of the new waste treatment system, the Contractor shall take ties and top of pipe elevations at sufficient intervals along all pipelines to permit the accurate location of the pipe (particularly any buried ends or fittings) and shall take locations and elevations of all tanks and structures after backfilling. Ties shall be to permanent physical points which may be accurately reproduced. An accurate As Built Survey Plan in AutoCAD format shall be provided by the Contractor to the Owner at completion of construction. The As Built Survey Plan must be completed by a MA licensed surveyor or Professional Engineer or approved equal qualified skilled contractor staff.

B. The Contractor shall review the location of all tie points with the Engineer prior to backfilling the sewer pipe and other components of the sewage treatment system.

3.22 EQUIPMENT AND PRODUCT WARRANTY

A. All equipment and products provided under this section requires a minimum of a two year warranty from defects of product failure or installation including but not limited to all new process precast tanks, manhole and piping which must pass leakage tests as noted in this section. This two year warranty is required by the Town of Plymouth. **(CRITICAL)**

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Section 33 30 01

SANITARY SEWERAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 REFERENCES

A. All work specified in this Section shall conform to the standard requirements of the Town of Plymouth and the Commonwealth of Massachusetts Standard Specifications for Highway and Bridges, latest revision, herein referred to as “State Standards” Specifically Section 200, 230, and 140.

B. All sanitary sewers and appurtenances shall be designed and constructed in accordance with TR-16, “Design and Construction of Sanitary and Storm Sewers” as prepared by the Technical Advisory Board of the New England Interstate Water Pollution Control Commission.

C. All work shall conform to the following standards

1. ASTM D 3034 Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings.
2. ASTM D 3212 Joints for Sewer Pipes using Flexible Elastomeric Seals Federal Specification.
3. SS-S-210 Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints.
4. ASTM C 923 Standard Specification for resilient connectors between reinforced concrete manhole structures, pipes, and laterals.

D. All work shall be performed in accordance with the requirements of the Commonwealth of Massachusetts Department of Environmental Protection sanitary sewer requirements. Fines resulting from not conforming to the requirements shall be paid by the Contractor and at no additional expense to the Owner.

1.3 SUMMARY

A. This Section includes gravity-flow, non-pressure and pressurized sanitary sewerage outside the buildings, with the following components:

1. Manholes
2. SDR-35 PVC Gravity Sewer Pipe
3. Cleanouts

1.4 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

B. SDR: Standard Dimension Ratio

1.5 PERFORMANCE REQUIREMENTS

A. Pipe used for gravity flow sanitary sewers shall be SDR-35 PVC unless specified otherwise on the Drawings.

1.6 SUBMITTALS

A. Provide Shop Drawings for the following:

1. Pipe: Include specifications on pipe materials, dimensions, fittings and joint details, construction details, tolerance and physical characteristics.
2. Manholes: Include plans, elevations, Sections, details of structures, frames, and covers. Include design calculations, reinforcement product information, and concrete design-mix report.
3. Rubber Boot Connections: Provide product specifications, materials, manufacturer's information, and recommended installation procedure.
4. Cleanouts: Include frame and covers specifications and loading criteria.
5. Pump Station (see specification Section 323216 Sanitary Sewer Lift Station, Piping, and Related Equipment).

B. Conformance Certificates: Each shipment of castings, pipe, pipe fittings, and appurtenances, shall be accompanied by the manufacturer's notarized certification and cylinder testing that materials meet specified requirements.

C. Guarantee: The Contractor shall furnish to the Architect a written guarantee signed by the manufacturer of the pipe and pipe fittings which he proposes to furnish, which shall warrant and guarantee that the pipe and pipe fittings meet all requirements of the specifications and that the pipe and fittings shall not fail or be injured as a result of conveying sewage, drainage, industrial wastes or groundwater. The form of guarantee shall, in all respects, be satisfactory to the Architect.

D. Permits

1. Provide Architect and Owner's Representative with copy of all permits required prior to commencing work.

E. Field quality-control test reports for field manhole and pipe testing.

F. Record Drawings (see specification Section 029500 Site As-built Survey).

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store pipe on flat surface which provides even support for the pipe barrel with bell ends overhanging. Do not stack pipe higher than 5 feet. Do not store plastic pipe and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Deliveries shall be scheduled so that the progress of the work is at no time delayed and so that large quantities of products shall not be stored for excessive lengths of time in crowded locations or in locations where large storage areas might be considered objectionable.

D. Avoid damage to pipe from impact, bending, compression or abrasion during handling and storage.

E. Ship rubber gaskets in cartons and store in a clean area away from grease, oil, ozone producing electric motors, heat and the direct rays of the sun.

F. Use only nylon-protected slings to handle pipe. The use of hooks or bare cables will not be permitted.

G. The Contractor shall dispose of pipe damaged during delivery, handling, or storage and replace at no cost to the Owner.

H. Handle manholes according to manufacturer's written rigging instructions.

I. Use all means necessary to protect precast concrete units and materials before, during, and after installation and to protect the installed work and materials for all other trades.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Sewage Service: Do not interrupt service to facilities occupied by Owner or others anytime. Contractor is responsible for temporary connections from the existing high school and existing middle school to the storage tanks of the wastewater treatment plant. Contractor is responsible for the disposal of all sanitary waste collected in the tanks throughout construction. Disposal by pumping and trucking will be required until the wastewater treatment plant is online.

B. Sewer connections from the existing high school and middle school school will be phased and some proposed connections will be temporary. The existing high school will be in-use during portions of this Contract and the Contractor is responsible for proper function of all wastewater systems throughout the duration of the Contract unless otherwise specified.

C. Provide bypass system to maintain service to Owner's facility at no additional expense to the Owner.

1. All equipment and materials required to construct bypass system shall be purchased at the Contractor's expense.

D. TEMPORARY COLLECTION AND DISPOSAL OF SANITARY WASTE

1. See specification Section 33 30 00 for further description on temporary control, collection, and disposal of sanitary waste from existing facilities.

1.9 PERMITS

A. The Contractor shall obtain any permits required by the local authority prior to commencing with work affecting the sanitary sewer system.

B. No work shall commence until the Contractor has acquired all required permits and receives authorization from the Owner.

C. All required permits shall be obtained by the Contractor at no additional expense to the Owner.

1.10 MARKINGS

A. Mark pipe with the following information applied at intervals of not more than 5 feet:
   1. Manufacturer's name or trademark.
   2. Nominal pipe size;
   3. Pipe classification;
   4. Applicable dimension ratio;
   5. Date and location of manufacturer;
   6. Applicable standard designation number.

PART 2 – PRODUCTS

2.1 IDENTIFICATION

A. Underground-Type Line Markers for Non-Metallic Pipelines: Manufacturer's standard permanent detection tape, bright-colored, continuous printed polyethylene tape with a metallic core for detection of non-metallic underground installations, intended for direct-burial service; not less than 6" wide x 4 mils. thick. Provide green detection tape with black printing reading "CAUTION SEWER LINE BURIED BELOW."

2.2 POLYVINYL CHLORIDE GRAVITY SEWER PIPE

A. PVC sewer pipe for gravity sewers and service connections shall conform to ASTM D 1784 and D-3034-SDR 35 with a minimum stiffness of 46 pounds per square inch, and shall meet the following specific requirements and exceptions:
   1. The pipe and fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusion or other injurious defects. The pipe shall be as uniform as commercially practical in color, capacity, density and other physical properties.
   2. Joints shall be bell and spigot. The bell shall consist of an integral wall Section with a solid cross Section rubber ring gasket factory-assembled, securely locked in place to prevent displacement. Joints shall conform to ASTM Standard D 3212.
   3. All fittings and accessories shall have dimensions as recommended by the manufacturer and have bell and/or spigot configurations compatible with that of the pipe. Fittings and accessories shall have integral wall Section with a solid cross Section rubber ring set in place to prevent dislocation.
   4. Pipe shall pass impact resistance test in accordance with ASTM D 2444 and minimum pipe stiffness test at 5% deflection in accordance with ASTM D 2412.
   5. The normal length of 12-inch size and smaller pipe shall be 12.5 feet and 15-inch size shall be no longer than 20 feet.
   6. Pipe and fittings shall be manufactured in the United States of America and shall be accompanied by the manufacturer's certificate of compliance, in addition to meeting the performance tests specified hereinafter.
   7. If requested by the Architect, six specimen lengths each 6-inches long of each size pipe shall be furnished by the Contractor for impact resistance test and three specimen lengths each 6-inches long of each size pipe for pipe stiffness test. These tests are to be made in accordance with ASTM D 2444 and ASTM D 2412, respectively, at the expense of the Contractor. No pipe shall be accepted if the tests do not meet the test requirements.

2.3 NONPRESSURE-TYPE PIPE COUPLINGS

A. Flexible Couplings: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end as manufactured by Fernco. Inc or equivalent.

2.4 POLYVINYL CHLORIDE PRESSURIZED SEWER FORCE MAIN PIPE

A. All force main pipe shall conform to ASTM D2241.

B. The pipe shall be homogenous throughout and free of cracks, holes, foreign inclusion, or other injurious defects. The pipe shall be as uniform as commercially practical in color, capacity, density, and other physical properties.

C. Joints shall be bell and spigot. The bell shall consist of an integral wall section with a solid cross section rubber ring factory-assembled, securely locked in place to prevent displacement. Joints shall conform to ASTM Standard D 1869 and F 477.

D. Pipe shall pass impact resistance test in accordance with ASTM D 2444 and minimum pipe stiffness test at 5% deflection in accordance with ASTM D 2412.

E. All fittings and accessories shall have dimensions as recommended by the manufacturer. All fittings shall be ductile iron mechanical joint with gasket compatible for SDR-21 PVC pipe

2.5 CLEANOUTS:

A. Force Main Pressure Cleanouts: Force Main cleanouts and valves shall be ductile iron as shown on the Drawings, and conform to the specification Section 02510 Water Distribution.

B. Gravity Sewer Cleanouts: PVC body with PVC threaded cap and cast-iron frame and cover. Include cast-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.

1. Frame and cover shall be Cast-Iron and shall be able to withstand H20-44 loading criteria.

2.6 MANHOLE MATERIALS:

A. Cement shall be Portland cement conforming to ASTM C150, Type III, high early strength.

B. Aggregate shall conform to ASTM C330 and shall be graded, crushed stone with a resulting unit weight of concrete of up to one hundred fifty five (155) pounds per cubic foot, and a minimum unit weight of not less than one hundred forty-eight (148) pounds.

C. Water shall be clear and free of injurious and deleterious substances.

D. Concrete: shall have a minimum strength of 4000 psi at twenty eight (28) days and a strength of 2400 psi at seven (7) days.

1. During the process of manufacturing of the units not less than two (2) test cylinders shall be tested at time release of the form and two (2) at age twenty-eight (28) days.

2. All compression test cylinders shall be made, cured and stored in accordance with ASTM C31. Cylinders shall be tested in accordance with ASTM C39.
3. All concrete shall be air entrained as specified per RIDOT Standard Specifications.

E. Admixtures shall only be used after prior approval of the Owner's Representative.

F. All reinforcing bars shall conform to the requirements of ASTM designation: A615, Grade 60.

G. Welded wire fabric shall conform to the requirements of ASTM designation: A185.

2.7 PRECAST CONCRETE MANHOLES, AND BRICK:

A. Precast Concrete Manhole sections shall be equal to that shown on the drawings and shall conform to ASTM Specifications C-478 and C-76 Class IV Wall "B". The horizontal joints between sections shall be sealed using a flexible butyl resin sealant and shall conform to Federal Specifications SS-S-210A and AASHTO M-198B. In addition, the horizontal joints on the inside and outside of the manhole and catch basin shall be sealed with a "Quick Plug" as manufactured by Parson or approved equivalent.

B. Brick shall conform to ASTM Specification C-32 for sewer brick, except that the table therein is amended to provide that the required minimum compressive strength in pounds per square inch shall be for any individual brick 3,000 or 5,000 for the average of five bricks selected at random. The maximum absorption of water by five-hour boiling test shall not exceed 16% for any individual brick or 12% for the average of any five bricks selected at random.

C. Unless otherwise noted on the Drawings, sanitary manholes less than or equal to ten (10) feet deep shall have an interior diameter of 48 inches. Manholes greater than ten (10) feet shall have an interior diameter of 60 inches unless otherwise noted. All manholes with interior drops shall have an interior diameter of 60 inches unless otherwise noted. Manholes with a depth greater than 12 feet shall have an interior diameter of 72 inches unless otherwise noted.

D. Openings for pipe insertions shall be round and shall be precast or cored only. The diameter of the opening shall be adequate to install a rubber boot seal. The cored or precast opening shall maintain a minimum undisturbed distance of 6" from manhole section joints. Flexible rubber boot shall be neoprene with stainless steel clamps and bands.

2.8 MANHOLE FRAMES AND COVERS

A. Manhole Frames and Covers shall be cast iron and conform to the details on the drawings. Cast iron shall conform to ASTM A-48, Class 30. The underside of the cover and upper side of lip frame must present parallel plane surfaces, and at these points of contact, the frames and covers shall be machined to prevent covers from rocking in the frames under traffic.

B. Frame and covers shall be capable of withstanding H-20 highway loading.

C. Covers shall bear evenly in the frame and both frame seats and covers shall be accurately fabricated so that covers are interchangeable for use with any and all frames. Where indicated, frames and covers shall be watertight, and locked. The

sizes and weights (medium duty, heavy duty) are shown on the detail sheets for special manholes.

D. Mortar shall consist of one part cement and two parts clean sand. No lime shall be used.

E. Covers shall have a non-slip surface and shall have the word “SEWER” inscribed.

F. Frames and covers shall be installed on the manholes as indicated on the drawings. They shall be well bedded and encased in cement mortar and accurately set to the grades indicated or as directed. Red clay brick with cement mortar shall be used to adjust grade of frame and cover. One half inch of cement mortar plaster cast shall be applied to exterior of red clay bricks.

2.9 MANHOLE STEPS

A. Manhole steps shall be manufactured of Copolymer Polypropylene plastic with ½” grade 50 steel reinforcement.

B. Steps shall conform to ASTM C-478 and Fed. Spec. FS RR-F-621.

C. The capacity of each step shall be 1000 lb. at 6-inch distance from wall and 1500 lb. at 4-inch distance from wall.

D. Steps shall measure 12 inches wide (min.) and extend 5 1/8 inches from wall.

E. Manhole steps shall be provided in each base, riser and top Section and shall be integrally cast in each; 12 inches O.C.

2.10 WATER PROOFING FOR UNDERGROUND STRUCTURES

A. Bitumastic asphalt shall conform to ASTM D449, Type A.

2.11 RUBBER BOOT

A. Rubber boot shall comply with ASTM C 923.

2.12 THRUST RESTRAINT:

A. Thrust restraint shall be provided for all bends, endcaps and changes in direction on the pressure sewer. Concrete thrust blocks shall be utilized for thrust restraint.

B. The bearing strength area of soil shall be sufficient to support 1½ times the anticipated working pressure in the pipeline but not less than 200 psi.

C. Thrust blocks shall be installed against undisturbed soil.

PART 3 - EXECUTION

3.1 GENERAL

A. At no time shall the installed sanitary sewer piping be used to convey stormwater from dewatering operations or runoff.

B. Excavating, trenching, and backfilling are specified in Section 310000 - EARTHWORK.

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. All lines, grades, measurements, layout staking and reference staking necessary for the proper location and satisfactory completion of the pipeline, appurtenances and other construction, shall be the responsibility of the Contractor.

C. All stakes, references and batter boards including original, additional or replacement, which may be required for the construction operations, shall be furnished, set and properly referenced by the Contractor. The Contractor shall be solely and completely responsible for the accuracy of the line and grade of all features of the work. Any errors or apparent discrepancies found in previous surveys, plans, specifications or special provisions shall be called to the Architect's attention by the Contractor for correction or interpretation prior to proceeding with the work.

D. Upon request of the Architect, the Contractor shall furnish copies of all data used in setting and referencing all stakes and other layout markings used by the Contractor.

E. Gravity-Flow and Force Main Pressure Piping shall use the following pipe materials as applicable: Use the following pipe materials as specified on the Drawings:

1. SDR 35, sewer pipe and fittings; gaskets; and gasketed joints (used for gravity sewer).
2. SDR 21, sewer pipe and fittings, gasket joints, and factory specific lubricant. (used for force main).

F. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

G. Install gravity-flow, non-pressure, drainage piping according to the following:

1. Install piping pitched down in direction of flow, to the slope indicated on the Drawings. An even alignment of the pipe shall be maintained.
2. Install piping with 36-inch minimum cover unless specified otherwise on the Drawings
3. The Contractor shall excavate around the bell portion of the pipe so the pipe barrel bears on the prepared bed.
4. Blocking is not permitted.
5. All pipes shall be clean and free of dirt before laying and open ends shall be kept covered and free of dirt during construction.
6. The work shall be conducted in such a manner that no loose excavation or other foreign material can enter the pipes.
7. Each pipe shall be held firmly in position by carefully and thoroughly tamping backfill material around the barrel of the pipe.
8. Where new pipes are to adjoin existing structures, extreme care shall be taken in coring into existing structure. Tight waterproof connections shall be made without interrupting service.

H. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

I. Where installing pipe below standing water table trench shall be dry and free of water and pipe bedding. Below bottom of pipe can be replaced with 1 ½" crushed stone.

J. Install force main, pressurized piping according to the following:

1. Set ring in groove. Ring shall be faced in proper direction, with color marking faced out. Smooth ring so that it seats evenly all around in the groove and is free from twists.
2. Apply only manufacturer's specified lubricant to the entire circumference of the pipe end including the bevel and 2" back from the pipe end. The coating should be about the thickness of a brush coat of enamel paint.
3. Push lubricated pipe end straight into the bell to stop mark. Any undue resistance during assembly indicates the ring may be twisted. In this case the joint should be pulled apart and reassembled.
4. Provide for pipe expansion by having the stop mark flush with the end of the bell. Care shall be taken to prevent joints already assembled in line from closing up.
5. In cutting pipe, a square cut is essential to insure ease of assembly. Use either a tubing cutter or a miter box or fine tooth carpenter's saw. The end shall be beveled to the correct taper both in angle and length. Use a factory finished beveled end as a guide.
6. Minimum cover over force main piping shall be 4'-0".
7. All fittings and bends in the pipeline shall be backed up with Class "B" Concrete thrust blocks.
8. All open ends of pipe shall be tightly closed at the end of each day.

K. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place watertight plug in end of incomplete piping at end of day and when work stops.

L. All trenches, when pipe laying is in progress, shall be kept dry and all pipes and fitting shall be laid accurately to the required lines and grades using laser beam techniques and shall be uniformly supported along their entire lengths. The bottom of the excavation shall be properly trimmed to permit making the joints. The pipe shall be bedded and backfilled in accordance with the details. Additionally, installation of the sanitary sewer below the water table may be expected and the installation of pumps, wells, or other work required to lower the water table to install sanitary sewer piping or structures shall be completed at no additional cost to the Owner.

M. The bell and rubber ring must be clean with no foreign material that could interfere with the proper assembly of the pipe spigot.

N. The pipe end must be clean. Wipe with a clean, dry cloth around the entire circumference from the end to one inch beyond the reference mark.

O. Lubricate the spigot end of the pipe, using only the factory specified lubricant supplied. Be sure to cover the entire spigot end circumference. The coating should be the equivalent of a brush coat of enamel paint. It can be applied by hand, cloth, pad, sponge, or glove.

P. Insert the spigot end into the bell so that it is in contact with the rubber ring. Keep the pipe lengths in proper alignment. Brace the bell while the spigot end is pushed in under the rubber ring, so that previously completed joints in the line will not be closed up. Push the spigot end in until the reference mark on the spigot end is flush with the end of the bell.

Q. Pipe may be easily assembled by hand and/or bar and block. Stabbing is not allowed and shall be avoided. The Contractor shall not push on the end of the pipe with a machine.

R. When the pipe laying is not in progress, the pipe shall be protected in such a way to prevent flotation. Any pipe, which has floated shall be removed from the trench and re-laid to the satisfaction of the Owner's Representative at the Contractor's expense.

S. The Contractor shall install piping as specified to within 5 feet of the building foundation. The Plumbing Contractor shall make the connection to the sanitary sewer from this point.

T. Where installing pipe below standing water table the trench shall be dry and free of water and pipe bedding. Trenching below bottom of pipe can be replaced with 1 ½" crushed stone.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, non-pressure, drainage piping according to ASTM D 2321 and ASTM D 2751 for elastomeric-seal joints and manufacturer's recommendations.

B. Machinery shall not be used to push the pipe into place. The pipe shall be pushed into place by hand. The use of a hammer or mallet is permitted, with the use of a board to shield the end of the pipe being struck by the hammer. The pipe shall not be directly contacted with a hammer or mallet.

3.4 MANHOLES

A. General: Install manholes complete with appurtenances and accessories indicated.

B. Form continuous concrete or brick channels and benches between inlets and outlet as specified on Drawings.

C. Install precast concrete manhole sections with sealants according to ASTM C 891.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements.

E. Inverts: Where pipe alignment permits, and where directed by the Architect, the pipe shall be continued through the manhole and the top half carefully and evenly cut away. Where changes in alignment occur, unless otherwise authorized by the Architect, inverts shall be constructed of brick and mortar with a smooth flow line and an even curve in accordance with the plans.

F. Joints: Pipe joints into manholes shall be constructed in accordance with the details shown on the plans. Complete details of the boot manufacture and installation shall be submitted for approval. All areas around pipes passing through walls of manholes and catch basins shall be completely filled with waterproof cement mortar to tightly fill any space through which water can pass.

G. Bricks shall be laid in a workmanlike manner, true to line, and the joints shall be carefully struck and pointed on the inside. Bricks shall be thoroughly wet when laid and each brick shall be laid in mortar so as to form full bed, end and side joints in one operation. The outside of the brickwork shall be neatly plastered with ½" layer of cement mortar as the work progresses. The brickwork shall be satisfactorily bonded to the concrete and cast iron frame. No brick masonry shall be laid in water, or any water allowed to rise on the brickwork until the masonry has set for at least 24 hours.

H. Rubber Boot: Connections shall be installed in accordance with the manufacturer's recommendation. The connection must pass the testing procedure described below.

I. Waterproofing: All exterior surfaces of underground manholes shall receive one coat of bitumastic asphalt waterproofing.

3.5 IDENTIFICATION

A. Materials and their installation are specified in Section 310000 - Earthwork. Arrange for installation of detectable green warning tapes directly over piping and at outside edges of underground manholes.

1. Use detectable warning tape over all piping and over edges of underground manholes.

3.6 FIELD QUALITY CONTROL

A. Testing shall be completed in accordance with the Town of Plymouth Requirements. At a minimum, the testing procedures below shall be completed.

B. Contract the Owner's Representative a minimum of 72 hours prior to testing. Provide results to Owner's Representative.

C. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between structures.

b. Deflection: To be determined by the Mandrel Test.

c. Crushed, broken, cracked, or otherwise damaged piping.

d. Infiltration: Water leakage into piping.

e. Exfiltration: Water leakage from or around piping.

2. The Contractor shall repair any defects or corrections required by the Architect.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified at no expense to the Owner.

4. Re-inspect and repeat procedure until results are satisfactory at no expense to the Owner.

D. Testing Manholes

1. All sanitary manholes affected by the work shall be vacuum tested prior to backfilling, including existing manholes to which new connections are made. A minimum waiting period of thirty days after installation is required for all testing.
2. Install vacuum tester and inflate compression band to affect a seal between the vacuum base and the new manhole, connect vacuum pump to the outlet part with the valve open, draw a vacuum of 10 inches of mercury, (HG), and close the valve.
3. The manhole shall pass the test if the vacuum remains at 10 inches of HG in a time greater than 60 seconds for a 48-inch diameter manhole, time greater than 75 seconds for 60-inch diameter manhole and time greater than 90 seconds for 72-inch diameter manhole.
4. If the manhole fails the initial test, the Contractor shall make proper repairs or replace the manhole and re-test at no additional compensation.

E. Testing Gravity Sewers

1. Low Pressure Air Test
   a. The Contractor shall, at his expense, conduct a line acceptance test. The test shall be performed according to stated procedures and in the presence of the Architect. A minimum waiting period of thirty days after installation is required for all testing. The line shall be flushed and cleaned prior to testing.
   b. All pneumatic plugs shall be seal-tested before being used in the actual test installation. One (1) length of pipe shall be laid on the ground and sealed at both ends with the pneumatic plugs to be checked. Air shall be introduced into the plugs to 25 psig. The plugs shall hold against this pressure without bracing and without movement of the plugs out of the pipe.
   c. After a manhole-to-manhole reach of pipe has been backfilled and cleaned, and the pneumatic plugs are checked by the above procedure, the plugs shall be placed in the line at each manhole and inflated to 25 psig. Low-pressure air shall be introduced into this sealed line until the internal air pressure reaches 4 psig greater than the average backpressure of any groundwater that may be over the pipe. At least two minutes shall be allowed for the air pressure to stabilize.
   d. After the stabilization period (3.5 psig minimum pressure in the pipe), the air hose from the control panel to the air supply shall be disconnected. The portion of line being tested shall be termed "acceptable". If the time required in minutes for the pressure to decrease from 3.5 to 2.5 psig (greater than the average back pressure of any groundwater that may be over the pipe) shall not be less than 5 minutes.
   e. If the installation fails the air test, the Contractor shall, at his expense determine the source of leakage. He shall then repair or replace all defective materials and/or workmanship to Architect’s satisfaction and the pipeline shall be re-tested, all performed at no additional compensation to the Contractor.
2. Infiltration Test

a. The infiltration test shall be conducted at such time as the ground water level is at a height of not less than one foot above the top of the pipe for the full length of the Section of sewer being tested.

b. Each manhole-to-manhole reach shall be tested separately. At no time will the Contractor be allowed to test more than one manhole-to-manhole reach.

c. The Contractor shall construct such weirs or other means of measurement as shall be required and shall do such pumping as shall be necessary to enable the tests to be made satisfactorily.

d. The groundwater leakage into the pipes will be measured by the Owner or Architect after a minimum of one hour and the infiltration rate shall not exceed 50 gallons per day per mile per inch-diameter.

F. Pipe Deflection

1. Pipe provided shall be so installed that there be a maximum deflection of 5 percent determined by the Mandrel Test. Such deflection shall be computed by multiplying the amount of deflection (nominal diameter of the pipe less minimum diameter when measured) by 100 and dividing by the nominal pipe diameter.

2. The Contractor shall measure the amount of deflection by pulling a specially designed gauge assembly through the completed Section after 120 days of installation. The gauge assembly shall be in accordance with the recommendations of the pipe manufacturer and be acceptable to the Architect.

3. Should the installed pipe fail to meet this requirement, the Contractor shall do all work to correct the problem as the Architect may require without additional compensation.

4. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

5. Leaks and loss in test pressure constitute defects that must be repaired. All repairs shall be at the expense of the Contractor.

3.7 CLEANING

A. Interior of piping and manholes shall be cleaned of dirt and superfluous material prior to acceptance of sanitary sewer.

3.8 RECORD DRAWINGS

A. All installed underground utilities shall be designated on as-built drawings by the contractor of record and provided to the Owner and Architect in AutoCad electrical format prior to completion of the project. All as-built drawings, (underground and above ground) shall be dimensioned from permanent benchmarks such as existing buildings and include depths at various points throughout the extent of the work, and invert elevations at all structures.

3.9 CLEANOUT INSTALLATION:

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use PVC pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use heavy-duty cleanout frames and covers capable of withstanding HS-20-44 loading criteria in all areas.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 12 by 12 by 8 inches deep. Top of concrete block shall be laid 3" below finished grade. Top of frame shall be set flush with finish grade.

C. Set cleanout frames and covers in bituminous concrete and concrete pavement with top of frame flush with pavement surface. Top of concrete block shall be laid at the bottom of the bituminous binder course.

3.10 CLOSING ABANDONED SANITARY SEWERAGE SYSTEMS:

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes: Excavate around manhole and use either procedure below:

1. Remove manhole and close open ends of remaining piping.
2. Remove top of manhole down to at least 60 inches below final grade

3.11 TESTING SEWER FORCE MAIN

A. Leakage Tests

1. The contractor shall furnish all materials and equipment, install necessary pipe plugs, install necessary temporary pipe taps and make leakage tests; water used shall be fresh potable water supplied by the Contractor.
2. Leakage tests shall be conducted by maintaining the pipe under a pressure, as measured at the point of lowest elevation, of 150 psi or 1-½ times for at least 2-hours. Care should be taken to expel all air from the pipes when filling with water.
3. The quantity of water measured to maintain the test pressure shall not exceed 0.09 gallons per inch of diameter per 24-hours per joint.

B. If the leakage exceeds this rate, the Contractor must repair, replace or relay sections of pipe and repeat the tests until satisfactory to the Owner's Representative at no additional cost to the Owner.

3.12 CLEANING:

A. Interior of piping and manholes shall be cleaned of dirt and superfluous material prior to acceptance of sanitary sewer.

End of Section

Section 334000

STORM DRAINAGE SYSTEMS

PART 1 - GENERAL

1.1 WORK TO BE PERFORMED

A. Work under this Section includes furnishing all plant labor, equipment, appliances and materials, and performing all operations in connection with the construction of stormwater collection systems at the locations and to the lines and grades indicated on contract drawings and/or directed.

B. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is NOT a proprietary specification and it should be noted that "Or equal" applies to all products denoted herein. It is understood that all manufactures will have minor variations in configuration, appearance, and product specifications and such minor variations shall not eliminate such manufacturers as an equal". It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that are able to supply similar products.

C. Manufacturer of the treebox filters shall have a minimum of 5 years of experience in producing said systems for commercial use and a minimum of 2,000 installed operational units.

D. This Section includes geomembrane liners for ponds and reservoirs.

1. Related Sections:
   a. Division 31 Section 31 00 00 – Earthwork, for excavating, compacting, and grading the subgrade; for excavating and backfilling the anchor trench; for protecting the earthwork; for adding requirements for the earth cover; and for the filter fabric and other geotextiles.
   b. Division 31 Section 31 23 19 – Dewatering and Drainage, for removing ground water from subgrade to the extent required by liner manufacturer.

1.2 DEFINITIONS

A. Plastic Terminology: See ASTM D 1600 for definitions of abbreviated terms for plastics not otherwise defined in this section.

B. EPDM: Ethylene-propylene-diene terpolymer

1.3 REFERENCES

A. All work specified in this Section shall conform to the standard requirements to the Commonwealth of Massachusetts Standard Specifications for Highway and Bridges, latest revision, herein referred to as "State Standards" Specifically Section 200, 230, and 140 and the Town of Plymouth Standards.

B. ASTM C891, Standard Practice For Installation of Underground Pre-cast Utility Structures.

1.4 SUBMITTALS

A. Refer to SECTION 013300 – SUBMITTAL PROCEDURES for submittal provisions and procedures.

B. The Contractor shall submit for approval, manufacturer's printed recommendations for the storage, protection, handling, installation and testing of storm water piping, fittings and appurtenances, which shall be strictly adhered to by the Contractor.

C. Manufacturer testing results indicating compliance with the specifications herein.

D. Licenses required by the municipality or state government to install storm drainage systems shall be submitted prior to the commencement of any work on the storm water collection system.

E. It is required to have the Installer maintain an experienced full-time supervisor on Project site when earthwork is in progress.

F. Submit shop drawings including plans, sections, and testing documentation for all products and calculations for underground stormwater systems and hydrodynamic separator.

G. Manufacturer shall warranty all components of the treebox filter for a minimum of two years provided that the unit is operated and maintained in accordance with the manual. Improper operation, maintenance, or accidental or illegal activities (ie. Dumping of pollutants and vandalism) will void the warranty.

H. Geomembrane liners:

1. Product Data: For each type of product indicated. Include the following:
   a. Sheets for geomembrane liners.
   b. Seaming adhesives, solvents, and extrusions.
   c. Penetration assemblies.
2. Shop Drawings: Show fabrication and installation details for geomembrane liners. Show panel layout, seams, penetrations, perimeter anchorage, and methods of attachment and sealing to other construction. Differentiate between factory and field seams and joints.
3. Samples: For the following products, in sizes indicated:
   a. Geomembrane Panels: For each type, not less than one 12-inch seam length for factory-bonded sheets and one 12-inch seam length for field-bonded sheets.
4. Qualification Data: For qualified testing agency.
5. Product Certificates: For each type of geomembrane liner, from manufacturer.
6. Product Test Reports: For each geomembrane sheet, based on evaluation of comprehensive tests performed by a qualified testing agency.
7. Source quality-control reports.
8. Field quality-control reports.
9. Maintenance Data: For geomembrane liner to include in maintenance manuals.
10. Warranty: Special warranty specified in this Section.

1.5 DELIVERY, STORAGE AND HANDLING

A. Pipes shall be handled with care and in strict accordance with manufacturer's recommendations.

B. Materials and equipment shall be progressively delivered at the site so that there will be neither delay in the progress of the work nor an accumulation of materials that is not to be used within a reasonable time. Materials shall be so stored as to assure the preservation of their quality and fitness for the work.

C. Contractor will be responsible for unloading delivered treebox filter products.

D. Stored materials, even though approved before storage, may again be inspected prior to their use in the work. Stored materials shall be located so as to facilitate their prompt inspection.

E. Private property shall not be used for storage purposes without written permission of the owner or lessee, and if requested by the Architect copies of such written permission shall be furnished to him/her. All storage sites shall be restored to their original condition by the Contractor at his expense.

F. Care shall be taken during transportation of the pipe such that it is not damaged.

G. Pipes shall be stored on level ground, preferably turf or sand, free of sharp objects, which could damage the pipe.

H. Prevent damage to the interior and exterior walls of the pipe. Raising pipes with hooks, dropping or placing large stones against pipe, rolling over stones or sharp objects/edges and dropping pipe are prohibited. All damaged pipe and fitting shall be removed from the project site and replaced at no additional expense to the Architect.

1.6 GUARANTEE/WARRANTY

A. Material Guaranty: Before any contract is awarded, the Bidder may be required to furnish without expense to the owner complete statement of the origin, composition and manufacture of any or all materials proposed to be used in the construction of the work, together with samples, which may be subjected to the tests required by the owner to determine the quality and fitness of the material.

PART 2 - PRODUCTS

2.1 GENERAL

A. All products as specified herein shall be new, unused and purchased specifically for this Contract.

2.2 HIGH DENSITY POLYETHYLENE PIPE (HDPE):

A. High-Density Polyethylene Pipe and fittings shall be ADS N-12 IB ST Smooth Interior Pipe, ADS N-12 IB ST High Capacity Large Diameter Pipe or approved equivalent. Joints shall be soil-tight and include a rubber gasket on the spigot end of the pipe. When installed into the bell end, the joint shall be sealed.

B. Pipe shall conform to AASHTO M294 (Type 'S') for the specified diameters and strength classes.

C. Pipe shall be rated to withstand H-20 Loading Criteria with 18” of cover.

2.3 PVC PIPE AND FITTINGS

A. PVC Profile Gravity Sewer Pipe and Fittings: ASTM F 794 pipe, with bell-and-spigot ends; ASTM D 3034 fittings, with bell ends.

B. The pipe and fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusion or other injurious defects. The pipe shall be as uniform as commercially practical in color, capacity, density and other physical properties.

C. Joints shall be bell and spigot. For SDR-35 PVC pipe, the bell shall consist of an integral wall section with a solid cross section rubber ring factory-assembled, securely locked in place to prevent displacement. Joints shall conform to ASTM Standard D 3212. For SCH 40 PVC piping, joints shall be glued with PVC cement approved by the manufacturer.

D. All fittings and accessories shall have dimensions as recommended by the manufacturer and have bell and/or spigot configurations compatible with that of the pipe.

E. Pipe shall pass impact resistance test in accordance with ASTM D 2444 and minimum pipe stiffness test at 5% deflection in accordance with ASTM D 2412.

F. The normal length of 12-inch size and smaller pipe shall be 12.5 feet.

G. Pipe and fittings shall be manufactured in the United States of America and shall be accompanied by the manufacturer's certificate of compliance, in addition to meeting the performance tests specified hereinafter.

H. PVC pipe shall be SCH 40 where pipe has less than 2 feet of cover or as indicated on the plans.

I. PVC perforated pipe shall conform to ASTM/ANSI D 2759 or ASTMF 810. Perforations shall be 5/8” holes on 5” centers.

2.4 MANHOLES, CATCH BASINS, AND CASTINGS

A. Precast concrete drainage manholes and catch basins, and castings for manhole covers, catch basin grates and frames shall be in accordance with Section 330513, Manholes and Catch Basins.

2.5 CATCH BASIN HOODS

A. All catch basin outlet pipes on new catch basins and all outlet pipes on existing catch basins shall be fitted with a catch basin hood.

2.6 OUTLET CONTROL STRUCTURES

A. Provide precast control structures, outlet structures shall conform to the dimensions shown on the plans and details and shall include a including galvanized steel bar grate fastened to the top of the unit. Outlet control structures shall be precast concrete units designed for AASHTO HS20-44 loading, with openings as shown on the detail drawings.

2.7 STORMWATER HYDRODYNAMIC SEPERATOR

A. Acceptable suppliers may be Vortsentry Contech Stormwater Solutions, Hydroguard by Hydroworks, Downstream Defender, or approved equivalent.

B. Materials and Design

1. Concrete for precast stormwater treatment systems shall conform to ASTM C857 and C478 and meet the following additional requirements:
   a. In all cases the wall thickness shall be no less than the minimum thickness necessary to sustain HS20 loading requirements.
   b. Sections shall have tongue and groove or ship-lap joints with a butyl mastic sealant conforming to ASTMT C990.
   c. Cement shall be Type I, II, or III Portland cement conforming to ASTM C150.
   d. All sections shall be cured by an approved method. Sections shall not be shipped until the concrete has attained a compressive strength of 4,000 psi (28 MPa) or other designate suitable handling strength.
   e. Pipe openings shall be sized to accept pipes of the specified size(s) and material(s), and shall be sealed by the Contractor with a hydraulic cement conforming to ASTM C595M.

C. Performance

1. Each stormwater treatment system shall have treatment, sediment storage, and oil storage capacities equal to or greater than that shown on the table below. For the purpose of determining equivalency, the treatment capacity shall be defined as the flow rate at which the stormwater treatment system removes 80% of an unground silica sample having an average particle size equal to or less than 240 microns. Treatment capacity shall be additionally defined as the maximum flow rate prior to which bypass of any flow occurs. Calculations must be provided to show the below criteria are met with the shop drawing for the treatment system submitted.

Structure	**Rim (ELEV)**	**Inv In (ELEV)**	**Inv Out (ELEV)**	**Pipe**	**25 year Flow (CFS)**	**Water Quality Flow (CFS)**	**WQV (CF)**
HS-201	206.03	196.70	196.70	24” HDPE	9.08	9.08	4241
HS-400	213.22	206.27	206.27	24” HDPE	14.86	14.86	9492

2. Each stormwater treatment system shall provide documented full-scale testing that corroborates the capacities as listed in the table above and defined above. Said documentation shall include at a minimum testing for removal capabilities and sediment wash-out characteristics at the treatment capacities listed in table above.
3. Each stormwater treatment system shall have the capability of bypassing high flow internally as well as controlling through the treatment chamber so as to avoid wash-out of previously captured pollutants under high flow conditions.
4. Each stormwater treatment system shall include a circular chamber with a tangential inlet to induce a swirling flow pattern within the treatment chamber.

The outlet from the treatment chamber shall be located in the center of the chamber so as to maximize the particle flow path within the treatment system.

5. Each stormwater treatment system shall be of a hydraulic design that includes flow controls designed and certified by a professional engineer using accepted principles of fluid mechanics that raise the water surface inside the tank to a pre-determined level in order to prevent the re-entrainment of trapped floating contaminants.
6. Each stormwater treatment system shall be designed to not allow surcharge of the upstream network during dry weather conditions.
7. Each stormwater treatment system shall be contained within one concrete manhole structure.

2.8 CHAMBER SYSTEM

A. The chamber shall be constructed of injection molded polypropylene impact copolymer formulated for high impact and stress cracking resistance and sustained structural performance during high temperatures. The chamber shall be in accordance with ASTM F2418-05 standards.

B. The chamber shall be designed to AASHTO LRFD Bridge Design Specifications (Section 12), as applied to material and performance requirements for buried thermoplastic pipes. Design live load shall be the AASHTO HS-25 or HS-20 truck and applies to chamber spacing of 5” (127 mm) or greater.

C. The chamber system shall be comprised of three chamber configurations. The MIDDLE chambers shall be open-ended to allow unobstructed hydraulic flow, inspection, and maintenance. The START and END chambers shall each have an integral end wall designed to resist loading at the start and end of the chamber rows. The chambers within a row shall be installed with overlapping and corrugations.

D. The nominal dimensions of the START chamber shall be 51.4 inches (1306 mm) wide, 30.3 inches (770 mm) tall, and 98.4 inches (2500 mm) long. The nominal dimensions of the MIDDLE chamber shall be 51.4 inches (1306 mm) wide, 30.3 inches (770 mm) tall, and 91.0 inches (2311 mm) long. The nominal dimensions of the END chamber shall be 51.4 inches (1306 mm) wide, 30.3 inches (770 mm) tall, and 92.0 inches (2337 mm) long. The nominal storage volume inside the chamber shall be 77 cubic feet (2.17 cubic meters) when utilizing 6” (152 mm) of stone above and below chamber with 40% stone porosity.

E. The chamber shall have a continuously-curved, arch-shaped section profile.

F. The START and END chamber integral end wall shall be structurally suitable for cutting and inserting inlet pipes and shall provide a range of pipe diameter indicants up to 24” (610 mm) diameter as cutting templates.

G. The chamber shall be a corrugated, open-bottom design with 0.4” (10 mm) wide x 1.5” (38 mm) tall slotted side wall openings for lateral flow and top vent orifices for hydraulic pressure equalization. Corrugation valleys and crests shall be sub-corrugated to increase stiffness.

H. The chamber shall have a circular cut line for an optional reinforced inspection or cleanout port configured to accept a 4” (102 mm) Schedule 40 pipe.

I. The END chambers shall be capable of being cut to shorter lengths to

accommodate site specific requirements.

J. The chamber shall be supported by integral structural footings comprised of load dispersing toe ribs and longitudinally aligned stiffening ribs.

2.9 WATER QUALITY SWALES

A. Water quality swales shall have a media bed depth as shown on the plans and with a media comprised of 50% sand and 50% loam and a 6” gravel depth. Sand, loam, and gravel shall conform to materials outlined in section 31 00 00. ‘

2.10 AREA DRAINS

A. PVC surface drainage inlets shall include the drain basin type as indicated on the contract drawing and referenced within the contract specifications.

B. The ductile iron grates for each of these fittings are to be considered an integral part of the surface drainage inlet and shall be furnished by the same manufacturer.

C. Drain basins grates in hardscaped areas shall be ADA compliant. Drain basin grates in landscaped areas shall be standard grates.

D. The drain basins required for this contract shall be manufactured from PVC pipe stock, utilizing a thermoforming process to reform the pipe stock to the specified configuration. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. This joint tightness shall conform to ASTM D3212 for joints for drain and sewer plastic pipe using flexible elastomeric seals. The flexible elastomeric seals shall conform to ASTM F477. The pipe bell spigot shall be joined to the main body of the drain basin or catch basin. The raw material used to manufacture the pipe stock that is used to manufacture the main body and pipe stubs of the surface drainage inlets shall conform to ASTM D1784 cell class 12454.

E. The grates and frames furnished for all surface drainage inlets shall be ductile iron and shall be made specifically for each basin so as to provide a round bottom flange that closely matches the diameter of the surface drainage inlet. Grates for drain basins shall be capable of supporting various wheel loads as specified. Ductile iron used in the manufacture of the castings shall conform to ASTM A536 grade 70-50-05. Grates and covers shall be provided painted black.

2.11 TRENCH DRAINS

A. Acceptable products for this application include Poly drain by ABT Inc., ACO, Duraslope by NDS, or Approved Equivalent.

2.12 TREEBOX FILTERS

A. Each manufactured system shall consist of a precast concrete container together with an underdrain system, filter media, plant material, and appropriate grate landscape cover where applicable.

1. Concrete for precast unit shall conform to the following:

a. The wall thickness shall not be less than 150mm (5”) or as shown on the dimensional drawings. In all cases, the wall thickness shall be no less than the minimum thickness required to meet loading requirements of the application.

b. The precast concrete unit shall be cured by an approved method. The unit shall not be shipped until the concrete has attained 85% if its design compressive strength.

c. The connections shall be provided to accept pipes of the specified size(s) and material(s).

2. Performance criteria:

a. The media shall achieve flow rate equivalent to a minimum of 140 inches per hour and verified via third-party report.

b. The unit shall remove 80% Total Suspended Solids (TSS) using a sil-co-sil 106 typical particle size distribution in the laboratory. Field results should show at least 80% TSS removal following either TAPE or TARP protocols.

c. The unit shall be located to ensure that high flow events shall bypass the filter media preventing erosion and re-suspension of pollutants.

2.12 EPDM SHEET MATERIALS

A. EPDM Sheet: Formulated from EPDM, compounded for use in hydraulic structures and formed into uniform, flexible sheets.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Firestone Building Products.

b. Raven Industries, Inc.

c. Yunker Plastics, Inc.

2. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.

a. Construction: [**9 x 9 - 1000 d**] [**10 x 10 - 1000 d**].

3. Nominal Thickness: [**45-mil-**] thick sheet per ASTM D 5199 or ASTM D 751, Optical Method.

4. Breaking Strength: Not less than [**190 lbf**] minimum average per ASTM D 882, ASTM D 7004, or ASTM D 751, Procedure A.

5. Tear Resistance: Not less than [**130 lb**] minimum average per ASTM D 1004.

6. Puncture Strength: Not less than [**60 lbf**] minimum average per ASTM D 4833.

B. Fabrication:

1. Fabricate geomembrane liner panels from sheets in sizes as large as possible with factory-sealed seams, consistent with limitations of weight and installation procedures. Minimize field seaming.

C. Source Quality Control:

1. Testing Agency: Engage a qualified testing agency to evaluate geomembrane seams.

2. Destructive Testing: Test for bonded seam strength and peel adhesion every 3000 feet or once per panel, whichever is more frequent.

3. EPDM Liner: Test and inspect factory seams, according to ASTM D 4545, for peel adhesion not less than 10 lbf/in. of seam width and for bonded seam strength not less than 160 lbf/in. of seam width for seams constructed from

two scrim-reinforced sheets, each with nominal sheet thickness of not less than 45 mils.

2.13 MISCELLANEOUS MATERIALS

A. Adhesives: Provide types of adhesive primers, compounds, solvents, and tapes recommended in writing by geomembrane liner manufacturer for bonding to structures (if required), for sealing of seams in geomembrane liner, and for sealing penetrations through geomembrane liner.

C. Penetration Assemblies: Provide manufacturer's standard factory-fabricated assemblies for sealing penetrations. Include joint sealant recommended in writing by geomembrane liner manufacturer and compatible with geomembrane liner, containment conditions, and materials.

D. Battens: Long-length strips of material indicated, size as shown on Drawings. Fabricate battens with sharp projections removed and edges eased and then predrilled or punched for anchors. Provide anchors, or other type of attachment, of type and spacing recommended in writing by geomembrane liner manufacturer for attaching geomembrane liner system to substrate and as indicated.

1. Batten Material: Liner manufacturer's standard system.
2. Batten Material: Aluminum; with stainless-steel anchors, complete with gasket and sealant compatible with geomembrane liner, containment conditions, and materials.
3. Batten Material: Stainless steel; with stainless-steel anchors, complete with gasket and sealant compatible with geomembrane liner, containment conditions, and materials.
4. Batten Material: Plastic compatible with geomembrane liner, cast in place or fastened with stainless-steel anchors, designed to continuously seal geomembrane liner to batten.

PART 3 - EXECUTION

3.1 GENERAL

A. The installation of all pipes of various materials, structures, and connections to existing pipes/structures shall be made at the locations and elevations as shown on the drawings.

B. All materials and each part of detail of the work shall be subject to inspection by the Architect. The Architect shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the contractor as is required to make a complete and detailed inspection, (such assistance may include furnishing labor, tools and equipment at no expense to Architect.)

C. If the Architect so requests, the Contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed will be paid for as extra work; but should the work so exposed or examined prove unacceptable, the uncovering or the removing and the replacing of the covering or making good of the parts removed, will be at the Contractor’s expense.

D. Any work done or materials used without authorization by the Architect may be ordered removed and replaced at the Contractor's expense. The Contractor shall furnish written information to the Architect stating the original sources of supply of all materials manufactured away from the actual site of the work. In order to insure a proper time sequence for required inspection and approval this information shall be furnished at least two weeks in advance of the incorporation in the work of any such materials.

E. The Contractor shall give prior notice to the Architect when work on the various items is to be performed by him or his Subcontractors. If work is suspended on any item, prior notice shall be given to the Architect before resumption of such work.

3.2 TRENCH EXCAVATION AND BACKFILL

A. Excavation and backfill of piping shall be performed as specified in Section 31 00 00, EARTHWORK.

B. Pipe bedding shall be placed as specified in Section 31 00 00, EARTHWORK.

3.3 PIPE INSTALLATION

A. Use only nylon-protected slings to handle pipe. The use of hooks or bare cables will not be permitted.

B. PVC Piping: No machinery shall directly contact the PVC pipe to push the pipe into place. The pipe shall be pushed into place by hand. The use of a hammer or mallet is permitted, with the use of a board to shield the end of the pipe being struck by the hammer. The pipe shall not be directly contacted with a hammer or mallet. Any pipe damaged while being pushed into place or while being laid in the trench shall be removed from the site and replaced at the expense of the Contractor.

C. HDPE Piping: An elastomeric rubber gasket supplied by the manufacturer shall be installed at each HDPE pipe joint to insure that each joint is silt tight.

D. Pipe shall be inspected before any backfill is placed. Any pipe determined by the Engineer to be out of alignment, unduly settled, or damaged shall be taken up and re-laid or replaced at no additional cost to Owner.

E. General Locations and Arrangements: Drawing plans and details indicate location and arrangement of underground storm drainage piping. Install piping as indicated, following piping manufacturer's written instructions.

F. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

G. If conflicts between utilities, the Contractor shall stop work on the utilities, contact the Engineer, and await direction from the Engineer.

H. Install piping with 36-inch minimum cover unless otherwise specified on the Drawings.

I. Install piping with a minimum slope as specified on Drawings.

J. Install PVC piping according to ASTM D 2321, ASTM F 1668, and manufacturer's

recommendations.

3.4 STORMWATER HYDRODYNAMIC SEPERATOR INSTALLATION

A. The stormwater treatment system shall be installed in strict accordance with the manufacturer's recommendations.

B. Excavation, bedding, backfill and compaction for the structure shall be as specified in Section 31 00 00, EARTHWORK.

C. The structure shall be watertight upon the completion of the installation.

3.5 CHAMBER INSTALLATION

A. Refer to Manufacturer's Installation Guide for proper procedure required to maintain structural integrity and functionality of the chamber system.

3.6 AREA DRAIN INSTALLATION

A. Install Trench Drain System according to manufacturer's requirements and specifications.

B. Set tops of grating frames and grates flush with finished surface, unless otherwise indicated.

C. The specified PVC surface drainage inlet shall be installed using conventional flexible pipe backfill materials and procedures.

D. The backfill material shall be crushed stone or other granular material meeting the requirements of class 1 or class 2 material as defined in ASTM D2321. Bedding and backfill for surface drainage inlets shall be well placed and compacted uniformly in accordance with ASTM D2321.

E. The drain basin body will be cut at the time of the final grade. No brick, stone or concrete block will be required to set the grate to the final grade height.

F. For load rated installations, a concrete slab shall be poured under and around the grate and frame. The concrete slab must be designed taking into consideration local soil conditions, traffic loading, and other applicable design factors.

3.7 TRENCH DRAIN SYSTEM INSTALLATION

A. Install Trench Drain System at elevations indicated.

B. Install Trench Drain System according to manufacturer's requirements and specifications.

C. Set tops of grating frames and grates flush with finished surface, unless otherwise indicated.

3.8 TREEBOX FILTER INSTALLATION

A. Each unit shall be constructed at the locations and elevations according to the sizes shown on the plans. Any modifications to the elevation or location shall be at the direction of and with approval by the engineer.

B. Inlet and outlet connections shall be aligned to meet the approved drawings with

modifications necessary to meet site conditions.

C. Once the unit is set, backfilling should be performed in a careful manner, bringing the appropriate fill material up in 150mm (5”) lifts on all sides. In all instances installation of filter unit shall conform to ASTM specification C891 “Standard Practice for Installation of Underground Precast Utility Structures.”

3.9 GEOMEMBRANE PREPARATION AND INSTALLATION

A. Examination:

1. Examine substrates, with Installer present, for compliance with requirements for soil compaction and grading; for subgrade free from angular rocks, rubble, roots, vegetation, debris, voids, protrusions, and ground water; and for other conditions affecting performance of geomembrane liner.
2. Examine anchor [**trench excavation**], where geomembrane liner will be secured, for substrate conditions indicated above and for correct location and configuration.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Provide temporary ballast, until edges are permanently secured, that does not damage geomembrane liner or substrate, to prevent uplift of geomembrane liner in areas with prevailing winds.

C. Prepare surfaces of construction penetrating through geomembrane liner according to geomembrane liner manufacturer's written instructions.

D. General: Place geomembrane liner over prepared surfaces to ensure minimum handling. Install according to Shop Drawings and in compliance with geomembrane liner manufacturer's written instructions. Begin placing geomembrane liner at Project's upwind direction and proceed downwind. Install geomembrane liner in a relaxed condition, free from stress and with minimum wrinkles, and in full contact with subgrade. Do not bridge over voids or low areas in the subgrade. Fit closely and seal around inlets, outlets, and other projections through geomembrane liner. Permanently secure edges.

E. Field Seams: Comply with geomembrane liner[**and floating cover**] manufacturer's written instructions. Form seams by lapping edges of panels 2 to 4 inches unless instructions require a larger overlap. Wipe contact surfaces clean and free of dirt, dust, moisture, and other foreign materials. Use solvent-cleaning methods and grind geomembrane seam surfaces if recommended by geomembrane liner manufacturer. Proceed with seaming at required temperatures for materials and ambient conditions. Continuously bond sheet to sheet to construct single or double seams of width recommended for method of seaming used. Seal or fuse free seam edges. Inspect seams and reseal voids.

1. Adhesive Bonding: Apply bonding cement to both contact surfaces in seam area and press together immediately, or use other seaming methods as instructed by geomembrane liner manufacturer. Roll to press surfaces together, to distribute adhesive to leading edges of panels, and to remove wrinkles and fishmouths. Remove excess adhesive.
2. Thermal Bonding: Use thermal-welding technique recommended by geomembrane liner manufacturer. Apply pressure to smoothly bond surfaces together. Examine for and patch wrinkles and fishmouths.

F. Installation in Anchor Trench: Install geomembrane liner in trench according to manufacturer's written instructions. Backfill and compact to lock liner into trench.

G. Liner Repairs: Repair tears, punctures, and other imperfections in geomembrane liner field and seams using patches of geomembrane liner material, liner-to-liner bonding materials, and bonding methods according to geomembrane liner manufacturer's written instructions. Apply bonding solvent or weld to contact surfaces of both patch and geomembrane liner, and press together immediately. Roll to remove wrinkles.

H. Field Quality Control:

1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Nondestructive Testing: Visually inspect seams and patches. Comply with ASTM D 4437 for Air Lance Test, Vacuum Box Testing, or Ultrasonic (High Frequency) Pulse Echo Testing or with GRI Test Method GM6, as applicable to geomembrane liner and seam construction. Record locations of failed seams and patches. Individually number and date occurrences and details of leak and remedial action. Repair leaking seams and patches.
3. Prepare test and inspection reports.

I. Disinfection:

1. Disinfect the complete installation according to procedures in AWWA C652.

J. Protection:

1. Protect installed geomembrane liner according to manufacturer's written instructions. Repair or replace areas of geomembrane liner damaged by scuffing, punctures, traffic, rough subgrade, or other unacceptable conditions.
2. Before initial filling of pond or placement of earth cover, inspect seams and patched areas to ensure tight, continuously bonded installation. Repair damaged geomembrane and seams and reinspect repaired work.

End of Section

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SECTION 43 21 00

LIQUID PUMPS

ALTERNATE NO. 1

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

A. Examine all conditions as they exist at the project prior to submitting a bid for the work of this SECTION.

B. Examine all Drawings and all other sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

C. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

1.2 SCOPE OF WORK

A. Provide all equipment and materials, and do all work necessary to construct the Dosing Tank installation complete, including, but not limited to the following:

1. Furnish and install two new submersible wastewater pumps in the new Dosing Chamber including all pump fittings, stainless steel chain, stainless steel guide rails, accessories, controls, alarms, spare parts, inspection and testing;
2. Coordinate and pay for inspection and testing observation of all of the work by the Town of Plymouth Board of Health and the Commonwealth of Massachusetts, Department of Environmental Protection, Division of Water Pollution Control, including obtaining final approval of the completed system from the Town of Plymouth Board of Health and the Commonwealth of Massachusetts, Department of Environmental Protection, Division of Water Pollution Control;
3. Provide all necessary start up services (dry test, punch list, cleanup, initial startup and wet test, including supplying sufficient water for the wet test), support for one year, staff and operator training associated with the new wastewater treatment facility;

All of the above work is as shown on the Drawings and as specified herein or as necessary to provide complete, operational sewage treatment system.

1.3 RELATED SECTIONS

A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:

1. Section 01 50 00, TEMPORARY FACILITIES AND CONTRACTS.

2. Section 03 10 00, SITE CLEARING.
3. Section 31 20 00, EARTH MOVING.
4. Section 33 30 00, SANITARY SEWAGE UTILITIES.
5. Section 05 00 00, METALS
6. Section 22 00 00, PLUMBING
7. Section 26 01 00, WASTEWATER TREATMENT PLANT ELECTRICAL (PART OF 26 00 00)
8. Section 44 41 13 PACKAGED WATER TREATMENT PLANTS

B. Section 01 23 00: Alternatives: Administrative requirements for alternates affecting work of this section.

1.4 ALTERNATES

A. Refer to Section 01 23 00 – ALTERNATES, for Alternate Number 1 which affects the work of this Section. This Alternate adds to the Contract deletes from the Contract work of this Section, which includes, but is not limited to the following:

1. Alternate 1 includes all work related to proposed WWTP as shown on the SS series drawings as well as other related drawings and specifications noted as Alternate 1.

1.5 REFERENCES

A. Codes and Standards: Materials and methods of installation, cleaning, and testing of sewerage system shall comply with local requirements, except where more stringent requirements are indicated.

B. Manufacturers: Firms regularly engaged in manufacture of materials of types and sizes required, whose products have been in satisfactory use in similar service for not less than five years.

C. Massachusetts Plumbing Code: Comply with applicable portions of the current edition of the Commonwealth of Massachusetts Plumbing Code unless more stringent regulations apply.

D. Massachusetts State Electrical Code: Comply with applicable portions of the current edition of the Commonwealth of Massachusetts Electrical Code unless more stringent regulations apply.

E. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirement shall govern.

1. American Society for Testing and Materials (ASTM):

A 48	Gray Iron Castings
A 74	Cast Iron Soil Pipe and Fittings
A 307	Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
A 536	Ductile Iron Castings
C 32	Sewer and Manhole Brick (Made from Clay or Shale)
C 62	Building Brick (Solid Masonry Units Made from Clay or Shale)
C 270	Mortar for Unit Masonry
C 478	Precast Reinforced Concrete Manhole Sections
C 564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings

C 828	Low-Pressure Air Test of Vitrified Clay Pipelines (4 to 12-in.)
C 891	Installation of Underground Precast Concrete Utility Structures
C 913	Precast Concrete Water and Waste Water Structures
D 2241	Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
D 2321	Underground Installation of Flexible Thermoplastic Sewer Pipe
D 2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipes and Fittings
D 2855	Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
D 3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D 3139	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
D 3212	Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
F 758	Smooth-Wall Polyvinyl Chloride (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage

2. American National Standards Institute (ANSI)

B16.5	Pipe Flanges and Flange Fittings
B31.1	Power Piping

3. American Welding Society (AWS)

B3.0	Welding Procedure and Performance Qualifications

4. American National Standards Institute/American Water Works Association (ANSI/AWWA):

C104/A21.4	Cement-Mortar Lining for Ductile Iron and Gray Iron Pipe and Fittings for Water
C105/A21.5	Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids
C110/A21.10	Ductile Iron and Gray Iron Fittings, 3 in. through 48 in., for Water and Other Liquids.
C111/A21.11	Rubber-Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings
C115/A21.53	Ductile Iron Compact Fittings 3 In., Through 16 In. for Water and Other Liquids
C150/A21.50	Development of Standard Thickness Design of Ductile Iron Pipe
C151/A21.51	Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
C153/A21.53	Ductile Iron Compact Fittings, 3 in. through 16 in., for Water and Other Liquids.
C500	Gate Valves, 3 through 48 In. NPS, for Water and Sewage Systems
C600	Installation of Ductile-Iron Water Mains and Their Appurtenances

5. American Water Works Association (AWWA)

Manual M11	Steel Pipe - A Guide for Design and Installation

6. Commonwealth of Massachusetts Highway Department (MHD):
   Standard Specifications for Highways and Bridges
7. Commonwealth of Massachusetts Department of Environmental Protection:
   310 CMR 15.00 et. seq. (Title V of the State Environmental Code), latest edition.

F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.6 EQUALS AND SUBSTITUTIONS

A. All bidders are reminded that the design plans and specifications for the project have been generally based on certain pumping equipment that has been selected by the Owner and Architect as meeting his requirements for the project. Pumping equipment for the FET Feed Pump Station, Flow Equalization and Dosing Pumps are included as part of WWTP under Section 44 41 13. FET Feed Pumps, Flow Equalization Pumps and Dosing Pumps are part of the BIOPROCESS proprietary treatment plant package and cannot be substituted.

B. The Contractor shall include with his bid a listing of the intended suppliers and manufacturers of the pumping equipment and controls and the precast concrete items. Each of these suppliers must certify that the material/equipment they intend to supply for the project meets the specifications and will function to provide the intended result.

C. All equipment and installation provided under this section must include a two year warranty against defects as required by the Town of Plymouth.

1.7 SUBMITTALS

A. The Contractor shall submit the following data (as a minimum) for the wastewater pumps and controls:

1. Pump data sheet stating the mechanical and electrical performance on the pumps and motors to be supplied along with complete calculations of all head losses involved in the pump station and force main system and shall certify that the equipment provided will be capable of functioning as intended, by pumping sanitary sewage from the bottom of the pump station wetwell, through the force main to the receiving sewer at the flow rate stated in the specifications.
2. To scale shop drawings of the pumps and motors, including all accessories and control cabinet.
3. Control data sheet clearly stating the alarmed conditions and with complete internal wiring diagrams. Cabinet layout of all controls and face plate diagram for the control cabinet.
4. Manufacturer's installation guides.
5. Technical manuals for all equipment.
6. Parts lists for all equipment, list of spare parts and fluids to be provided.
7. Manufacturer's Warranty.

B. The Contractor shall submit the following data documenting his experience in installing gravity sewers, major pumping stations and forcemains and the installation of the proposed system:

1. Statement of Qualifications of the equipment supplier and installing contractor. The installing contractor shall provide documentation that he has experience in installing pump stations, gravity sewers and forcemains similar in scope and nature to the proposed project and that he has installed at least three (3) similar systems of the type and size (22,000 GPD) to the proposed project within the last three (3) years.

C. Manufacturers Field Report of testing of the actual installation of his equipment on the project.

D. Project Record Documents.

E. Operation and Maintenance Data.

F. Warranties. The Town of Plymouth requires a two year warranty for all equipment provided and/or installed under this section.

1.8 OPERATION AND MAINTENANCE INSTRUCTIONS

A. All equipment manufacturers shall be responsible for supplying written instructions, which shall be sufficiently comprehensive to enable the operator of the equipment to operate and maintain the equipment supplied. Said instructions may assume that the operator is familiar with pumps, motors, piping, and valves, but that he has not previously operated and/or maintained the exact equipment supplied.

B. These instructions shall be prepared as a systems manual applicable solely to the equipment supplied by the manufacturer to these specifications, and shall include those devices and equipment supplied by him.

C. The instructions shall include, but no be limited to, the following:

1. Descriptions of, and operating instructions for each major component of the equipment supplied.
2. Instructions for operation of the equipment in all intended modes of operation.
3. Instructions for all adjustments which must be performed at initial startup of the equipment, adjustments which must be performed after the replacement of components and adjustments which must be performed in the course of preventive maintenance as specified by the manufacturer.
4. Instructions for the adjustment, calibration, and testing of selected electronic components or assemblies, normally considered replaceable by the manufacturer, whose performance is not ascertainable by visual inspection.
5. Service instructions for major components not manufactured by the equipment manufacturer but which are supplied by him in accordance with these specifications. The incorporation of literature produced by the actual component manufacturer shall be acceptable.
6. Electrical schematic diagram of the completed actual installation as supplied, prepared in accordance with National Machine Tool Builders Association (NMTBA) and Joint Industrial Council (JIC) standards. Schematics shall show, to the extent of authorized repair, motor branch, control, and alarm system circuits, and interconnections among these circuits. Wire numbers shall be shown on the schematic. Schematic diagrams for electronic equipment, the detail parts of which is not normally repairable by the station operator, need not be included, and shall not be substituted for an overall schematic diagram. Partial schematics, block diagrams, and simplified schematics shall not be provided in lieu of an overall schematic diagram.

D. Operation and maintenance instructions which are limited to a collection of component manufacturer literature without overall operational instructions related to this specific installation shall not be acceptable.

E. Operation and maintenance instructions shall be specific to the equipment supplied in accordance with these specifications. Instruction manuals applicable to many different configurations and which require the operator to selectively read portions of the instructions, shall not be acceptable.

F. The operation and maintenance data, when assembled into a complete package, shall meet all of the requirements of the Commonwealth of Massachusetts Department of Environmental Protection for Operation and Maintenance Manuals and the Town of Plymouth Board of Health.

1.9 CONDITIONS OF SERVICE, WORKMANSHIP AND DESIGN

A. The wastewater pumps shall be capable of discharging treated wastewater from a precast concrete Dosing Tank to the existing Leach Area as well as raw unscreened sewage from the Flow Equalization Tank to the waste treatment process. The pumps and controls shall all be new and shall be capable of operating properly, for an extended period of years, in a wet or humid environment.

B. Equipment parts shall be amply proportioned for long, continuous, and uninterrupted service. Suitable provisions shall be made for easy access for service or replacement of parts. Corresponding parts of multiple units shall be interchangeable.

C. Workmanship shall be first class in all respects.

1.10 QUALITY ASSURANCE

A. The entire work provided in this section shall be constructed and finished in every respect in a workmanlike and substantial manner, in strict accordance with the Drawings and specifications. It is intended that the Drawings along with the manufacturer's shop drawings substantially show all pipe, fittings and appliances; however, the Contractor shall furnish and install such parts as may be necessary to complete the systems in accordance with the best trade practice and to the satisfaction of the Architect.

B. The Contractor shall refer to all the drawings for a full comprehension of the work to be done and coordinate the work with other trades to avoid interference. Should any discrepancy appear or any misunderstandings arise, the Contractor shall request clarification by the Architect.

C. The Contractor shall be responsible for fully coordinating all of the various parts of the work included under this section, and such other work of this contract as it may affect the work of this section throughout various phases of construction and before the ordering or fabrication of the various parts of the work, so as to insure compliance with the drawings and specifications, and as necessary to provide performance in conformity with design requirements and satisfactory operating condition and operating sequences. Cooperate with such trades to assure the steady progress of all work under the Contract.

D. Source: For each type of material required for the work of this section, provide primary materials which are the products of one manufacturer. Provide secondary materials which are acceptable to the manufacturers of the primary materials.

E. The Contractor shall provide manufacturer's certification that materials meet or exceed minimum requirements as specified. Reference to standards such as ASTM and ANSI shall apply to those versions in effect at the time of bid opening.

F. Guarantees: In addition to the specific guarantee requirements of the General Conditions, the Contractor shall obtain extended guarantees for materials furnished under this section where such guarantees are offered in the manufacturer's published data. All these

guarantees shall be in addition to, and not in lieu of, other liabilities which the Contractor may have by law or other provisions of the Contract Documents.

1.11 DELIVERY, STORAGE AND HANDLING

A. All equipment, pumps, motors, controls and accessories shall be transported, unloaded, stored and handled in strict accordance with the manufacturer's instructions and recommendations. Protect from all possible damage.

1.12 TOWN OF PLYMOUTH AND STATE REQUIREMENTS

A. The Contractor shall notify and make all necessary arrangements with the Town of Plymouth Board of Health and MA DEP sufficiently in advance of the installation of the Flow Equalization Pumps and Dosing Pumps systems for any testing and inspection to occur.

B. All work and materials for the pump system installations shall be subject to approval of the Town of Plymouth Board of Health and MA DEP.

C. The Contractor shall be responsible for making all arrangements with the Town of Plymouth Board of Health and for paying all fees associated with the Flow Equalization and Dosing Pumps system installations, testing and inspection.

D. Comply with the rules, regulations, laws and ordinances of the Town of Plymouth, the Commonwealth of Massachusetts, appropriate agencies of the Commonwealth of Massachusetts, and all other authorities having jurisdiction. All labor, materials, equipment and services necessary to make the work comply with such requirements shall be provided without additional cost to the Owner.

E. Comply with the provisions of the Manual of Accident Prevention in Construction of the Associated General Contractors of America, Inc., and the requirements of the Occupational Safety and Health Administration (OSHA), United States Department of Labor.

F. The Contractor shall procure and pay for all permits and licenses required for the complete work specified herein and shown on the Drawings.

G. Any apparent conflict between the Drawings and Specifications and the applicable codes and regulations shall be referred to the Architect in writing, for resolution before the work is started.

1.13 INSPECTION AND TESTING

A. The Contractor shall be responsible for performing all tests required by the Town of Plymouth Board of Health, the Commonwealth of Massachusetts, Department of Environmental Protection, Division of Water Pollution Control and the Architect.

1.14 CONTRACTOR QUALIFICATIONS LICENSE

A. The Contractor installing the sewerage system shall have a minimum of three (3) years experience in work of the type required by this section and shall have installed at least three (3) systems with a design flow equal to or greater than the design flow for this project.

PART 2 - PRODUCTS

2.1 WASTEWATER PUMPS

A. The Contractor shall furnish and install three (3) slide rail mounted, electrically driven, non-clog submersible sewage pump systems as follows:

Flow Equalization Pumps (Part of Bid Process Treatment Plant Package under Section 44 41 13)

Provide (2) Transfer Pumps shall be Keen Model KG 2-23 2 hp, 480 volt 3 phase, lift out rail package with top rail support. Pumps rated for 30 gpm @ 25TDH.

The FET transfer pumps by Keen are included as part of the proprietary waste treatment process package by BIOPROCESS H2O LLC of Portsmouth, RI, but do not include stainless steel rails and chain. To be provided by contractor. See Division 44 41 13.

The control panel and VFD's controlling these pumps are included within the custom built PLC control Panel by Engineered Control Systems Inc. of Fall River MA. The Control Panel is part of proprietary waste treatment process equipment to be provided by BIOPROCESS.

Dosing Pumps (Included in BIOPROCESS Treatment Plant Package Under Section 44 41 13)

Provide two (2) Dosing Pumps as manufactured by ABS Model XFP100CCB1submersible sewage pumps 2.7 HP phase 480 volts rated for 100 gpm @ 19' TDH or approved equal.

Pump controls include VFD's to control two submersible pumps in dosing tank. Settings will allow operator to set variable discharge rates of flow to final Leach Area.

Stainless steel rails and chains to be provided by Contractor. See Division 44 41 13.

B. FET Feed Pumps (included in BIOPROCESS Treatment Plant package under Section 44 41 13.

Provide two (2) FET Feed Pumps as manufactured by ABS Submersible Sewage Pumps Model ABS XFP100CCB1, 3.75 HP 3 phase 480 volts rated at 200 gpm @26' TDH or approved equal.

Pump controls to control two (2) submersible pumps to existing Flow Equalization Tanks (FET). Include Float Controls for Pump OFF, Pump ON, Lag Pump ON and High Water Alarm to the existing FET tank.

The Control Panel is part of proprietary waste treatment process equipment to be provided by BIOPROCESS.

Stainless steel rails and chains to be provided by Contractor. See Division 44 41 13.

PART 3 - EXECUTION

3.1 Execution

A. This pump system and controls are part of the proprietary wastewater treatment

package by BIOPROCESS H2O. The Control Panel and VFD's controlling these pumps are included within the custom built PLC Control Panel by Control Systems, Inc. of Fall River, MA as part of the complete BIOPROCESS Treatment Package. The Control Panel is part of the proprietary waste treatment process because of its complexity.

B. Install all pumps per Contract Drawings and manufacturer's specifications.

C. Test all pumps per manufacturer's specifications and to be witnessed by BIOPROCESS as well as design Engineer.

D. All pumps and installation provided under this section shall include a minimum two year warranty from start up as required by the Town of Plymouth requirements. **(CRITICAL)**

END OF SECTION

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SECTION 44 41 13

PACKAGED WATER TREATMENT PLANTS
ALTERNATE NO. 1

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

A. Examine all conditions as they exist at the project prior to submitting a bid for the work of this SECTION.

B. Examine all Drawings and all other sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

C. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

D. Acceptable Substitutions: The Membrane Batch Reactor process (MBR) as provided by BIOPROCESS specified within this section has been determined to be in the public interest based on sound reasoning and will be voted as proprietary by the Owner. Under provisions of Massachusetts General Laws, Chapter 30, Section 39M (b) and Chapter 149, other equal products not named herein, may be considered for acceptance as an equal by the Engineer and Owner upon submission of complete product information as described in Section 01 25 13 – Product Substitution Procedures. Further additional information may be requested by the Owner or Engineer for determination that the proposed product substitution is fully equal to the specified product(s). The system specified herein has been approved by the Massachusetts Department of Environmental Protection for the Plymouth South High School and there is no guarantee that proposed substitutions will be approved, and the Contractor shall not order any materials until approval(s) are received in writing from the Owner and the Engineer.

1. Requesting substitutions shall be at the Contractor's own risk, with regard to uncompensated delays of the Project. Time will be required for sufficient review and additional requests for information by the Engineer and Owner. Delays which result from substitution reviews and resubmissions are not grounds for additional time or cost change orders, and will not be considered by the Awarding Authority.

E. A portion of the existing Wastewater Treatment Plant (WWTP) must be abandoned and decommissioned as required by the MA Department of Environmental Protection (DEP) 310 CMR 7.00 before any demolition activity occurs relative to the abandoned portions of the existing WWTP. Equipment/Tanks to be decommissioned are noted within the contract drawings. BWP AQ06 form must be filed on line to MA DEP. If any part of the demolition or WWTP decommissioning includes asbestos removal, an asbestos survey must be conducted, and the name of the firm conducting the survey must be given to DEP. A licensed asbestos inspector must conduct the survey before any equipment is demolished and all asbestos, if found, must be removed before the WWTP demolition commences.

1.2 RELATED SECTIONS

A. Section 01 23 00 – ALTERNATES: Administrative requirements for alternates affecting work of this Section.
B. Section 01 50 00 – Temporary Facilities
C. Section 03 10 00 – Site Clearing
D. Section 31 20 00 – Earth Moving
E. Section 33 30 00 – Sanitary Sewage Utilities
F. Section 05 00 00 – Metals
G. Section 22 00 00 – Plumbing
H. Section 26 01 00 – Wastewater Treatment Plant Electrical (Part of 26 00 00)
I. Section 43 21 00 – Liquid Pumps

1.3 ALTERNATES

A. Refer to Section 01 23 00 – ALTERNATES, for Alternate Number 1 which affects the work of this Section. This Alternate adds to the Contract deletes from the Contract work of this Section, which includes, but is not limited to the following:

1. Alternate 1 includes all work related to proposed WWTP as shown on the SS series drawings as well as other related drawings and specifications noted as Alternate 1.

1.4 SCOPE OF WORK

A. The work under this section includes furnishing, installing and testing a BIOPROCESS H2O process system as a proprietary product. The BIOPROCESS H2O treatment system is capable of treating wastewater with a maximum hydraulic flow of 22,000 gallons/day and a maximum organic load of 82.6 pounds of BOD_5 per day. The system shall be proprietary and be supplied by one manufacturer who shall be responsible to the installing contractor for providing the selected equipment for satisfactory operation of the system. The contractor shall install the system as shown on the plans and described herein. The system will include the following reactor internals provided by BIOPROCESS H2O:

- (2) FET FEED pumps and controls (Contractor to provide stainless steel rails and lifting chains, and fabricate standoff bracket)
- (2) flow equalization pumps and controls (Contractor to provide stainless steel rails and lifting chains, and fabricate standoff bracket)
- (1) mechanical bar screen
- (1) ultra filtration membrane skid assembly with (2) membrane modules
- (2) ultraviolet (UV) disinfection units
- Chemical feed assembly for alkalinity, carbon, and membrane cleaning
- 2 process blowers
- Odor control system
- Ultrasonic level controllers
- Metering pumps and accessories for process control
- Magnetic flow meters (6)
- Float switch
- pH transmitter

- aeration system for aeration tank
- Dissolved Oxygen (DO) analyzer
- Membrane Circulation pumps
- Turbidity Meter
- Membrane Permeate pump
- Denitrification pump
- Membrane Drain Sump Pump (Contractor to provide stainless steel rails and lifting chains, and fabricate standoff bracket)
- Two (2) Dosing Pumps and Controls (Contractor to provide stainless steel lifting chains, and fabricate standoff bracket)

All of the above described equipment is included within the BIOPROCESS H2O Equipment package. Refer to Liquid Pumps Section 43 21 00 for required Dosing Pumps and FET Feed Pumps and FET BIOPROCESS Feed Pumps (3-Pump Systems).

1.5 SHOP DRAWINGS, INSTALLATION INSTRUCTIONS AND O&M MANUALS

A. The Contractor shall submit the following data (as a minimum) for the advanced wastewater treatment system:

1. Design data prepared by the equipment supplier detailing all pertinent calculations for the Architect to verify that the proposed system will meet the discharge limits stated in Title V of the State Environmental Code and the DEP Wastewater Treatment Plant Design Guidelines.
2. Such supplemental calculations as may be requested by the Architect to verify that the proposed system will meet the discharge limits stated in Title V of the State Environmental Code and the DEP Wastewater Treatment Plant Design Guidelines as well as the approved engineer's report.
3. Blower, carbon vent fan, and motor data sheets stating the mechanical and electrical performance of all equipment proposed to be supplied along with complete calculations relating to each piece of equipment or motor.
4. Shop drawings of each individual component of and the completely assembled advanced wastewater treatment system.
5. Submittals for carbon odor control system.
6. Control data sheet clearly stating the alarmed conditions and with complete internal wiring diagrams.
7. Manufacturer's installation guides.
8. Technical manuals for all equipment.
9. Parts lists for all equipment, list of spare parts and fluids to be provided.
10. Manufacturer's Warranty.
11. Statement of Qualifications of the installing contractor. The installing contractor shall provide documentation that he has experience in installing the selected advanced treatment system and that he has installed at least three (3) similar treatment systems of the type and size (larger than 15,000 GPD) selected for use on the project within the last two (3) years.
12. Project Record Documents.
13. Operation and Maintenance Data.
14. Warranties including the process warranty.

B. The Installing Contractor shall submit his qualifications for doing the work for approval.

1.6 OPERATION AND MAINTENANCE INSTRUCTIONS

A. All equipment manufacturers shall be responsible for supplying written instructions, which shall be sufficiently comprehensive to enable the operator of the equipment to operate and maintain the equipment supplied. Said instructions may assume that the operator is familiar with pumps, motors, piping, and valves, but that he has not previously operated and/or maintained the exact equipment supplied.

B. These instructions shall be prepared as a systems manual applicable solely to the equipment supplied by the manufacturer to these specifications, and shall include those devices and equipment supplied by him.

C. The instructions shall include, but no be limited to, the following:

1. Descriptions of and operating instructions for, each major component of the equipment supplied.
2. Instructions for operation of the equipment in all intended modes of operation.
3. Instructions for all adjustments which must be performed at initial startup of the equipment, adjustments which must be performed after the replacement of components and adjustments which must be performed in the course of preventive maintenance as specified by the manufacturer.
4. Instructions for the adjustment, calibration, and testing of selected electronic components or assemblies, normally considered replaceable by the manufacturer, whose performance is not ascertainable by visual inspection.
5. Service instructions for major components not manufactured by the equipment manufacturer but which are supplied by him in accordance with these specifications. The incorporation of literature produced by the actual component manufacturer shall be acceptable.
6. Electrical schematic diagram of the completed actual installation as supplied, prepared in accordance with National Machine Tool Builders Association (NMTBA) and Joint Industrial Council (JIC) standards. Schematics shall show, to the extent of authorized repair, motor branch, control, and alarm system circuits, and interconnections among these circuits. Wire numbers shall be shown on the schematic. Schematic diagrams for electronic equipment, the detail parts of which is not normally repairable by the station operator, need not be included, and shall not be substituted for an overall schematic diagram. Partial schematics block diagrams, and simplified schematics shall not be provided in lieu of an overall schematic diagram.

D. Operation and maintenance instructions which are limited to a collection of component manufacturer literature without overall operational instructions related to this specific installation shall not be acceptable.

E. Operation and maintenance instructions shall be specific to the equipment supplied in accordance with these specifications. Instruction manuals applicable to many different configurations and which require the operator to selectively read portions of the instructions shall not be acceptable.

F. The operation and maintenance data, when assembled into a complete package, shall meet all of the requirements of the Commonwealth of Massachusetts Department of

Environmental Protection for Operation and Maintenance Manuals for advanced wastewater treatment systems.

1.7 CONDITIONS OF SERVICE, WORKMANSHIP AND DESIGN

A. The advanced wastewater treatment system shall be capable of treating raw, unscreened sewage from the new High School and existing Middle School, and discharging the effluent to the existing final leaching area. All equipment shall be new and shall be capable of operating properly, for an extended period of years, in a wet or humid environment.

B. Equipment parts shall be amply proportioned for long, continuous, and uninterrupted service. Suitable provisions shall be made for easy access for service or replacement of parts. Corresponding parts of multiple units shall be interchangeable.

C. Workmanship shall be first class in all respects. The Town of Plymouth requires a minimum of two year warranty for all equipment installed under this section. Two year warranty is the minimum. **(CRITICAL)**

1.8 QUALITY ASSURANCE

A. The entire work provided in this section shall be constructed and finished in every respect in a workmanlike and substantial manner, in strict accordance with the Drawings and specifications. It is intended that the Drawings along with the manufacturer's shop drawings substantially show all pipe, fittings and appliances; however, the Contractor shall furnish and install such parts as may be necessary to complete the systems in accordance with the best trade practice and to the satisfaction of the Architect.

B. The Contractor shall refer to all the drawings for a full comprehension of the work to be done and coordinate the work with other trades to avoid interference. Should any discrepancy appear or any misunderstandings arise, the Contractor shall request clarification by the Architect.

C. The Contractor shall be responsible for fully coordinating all of the various parts of the work included under this section, and such other work of this contract as it may affect the work of this section throughout various phases of construction and before the ordering or fabrication of the various parts of the work, so as to insure compliance with the drawings and specifications, and as necessary to provide performance in conformity with design requirements and satisfactory operating condition and operating sequences. Cooperate with such trades to assure the steady progress of all work under the Contract.

D. Source: For each type of material required for the work of this section, provide primary materials which are the products of one manufacturer. Provide secondary materials which are acceptable to the manufacturers of the primary materials.

E. The Contractor shall provide manufacturer's certification that materials meet or exceed minimum requirements as specified. Reference to standards such as ASTM and ANSI shall apply to those versions in effect at the time of bid opening.

F. Guarantees: In addition to the specific guarantee requirements of the General Conditions, the Contractor shall obtain extended guarantees for materials furnished under this section where such guarantees are offered in the manufacturer's published

data. All these guarantees shall be in addition to, and not in lieu of, other liabilities which the Contractor may have by law or other provisions of the Contract Documents. Minimum two year warranty required by the Town of Plymouth.

G. In the event a component fails to perform as specified or is proven defective in service during the guarantee period, the manufacturer shall repair or replace, at the discretion of the engineer, upon return of such defective part to the systems supplier. The repair or replacement of those items normally consumed in service, such as seals, grease, shall be considered as part of routine maintenance and upkeep.

H. The manufacturer shall guarantee for twelve (12) months from date of start-up, but not less than one full school year that the equipment furnished will be free from defects in design, material and workmanship. Warranties and guarantees of the suppliers of various components in lieu of a single source responsibility by the manufacturer will not be acceptable.

I. Process Guarantee: The manufacturer supplying the advanced wastewater treatment equipment and controls shall provide the Owner with a process warranty stating that the equipment provided will function as intended to produce treated effluent which meets the discharge limitations stated in these specifications and that if the system does not meet the discharge limitations stated in these specifications, the equipment supplier will provide and install additional units or equipment, AT NO ADDITIONAL COST TO THE OWNER, to meet the stated effluent limitations. The term of this warranty shall be for a minimum period of one full school year.

1.9 DELIVERY, STORAGE AND HANDLING

A. All treatment equipment, pumps, motors, controls and accessories shall be transported, unloaded, stored and handled in strict accordance with the manufacturer's instructions and recommendations. Protect from all possible damage.

B. During unloading of any Contractor purchased materials, the contractor shall take care to prevent damage to materials and coatings. The contractor shall carefully load and unload each piece of equipment using suitable equipment and labor so that the materials being unloaded are under control at all times. Place skids or blocks under each piece of equipment or materials and securely wedge pieces of equipment and materials during transportation to ensure no injury or damage to the material or equipment.

1.10 INSPECTION AND TESTING

A. The Contractor shall be responsible for performing all tests required by the Town of Plymouth Board of Health, the Commonwealth of Massachusetts, Department of Environmental Protection, Division of Water Pollution Control, and the Architect.

B. The BIOPROCESS H2O process system manufacturer shall furnish the services of a competent and experienced (not less than one full school year) factory-trained representative who has complete knowledge of proper operation and maintenance of the equipment. The representative shall be in attendance, for a period of not less than five (5) full working days, (eight {8} hours per day) on-site in a minimum of five (5) separate trips to inspect the installation of the media, and the mechanical equipment, to provide instructions to the plant operating personnel, to assist in plant start-up, to be present during the clear water test with the Commonwealth of Massachusetts Department of

Environmental Protection, and to be present during the process performance test. Additional days and trips, excluding those required to satisfy the process performance test, shall be reimbursed by the purchasing contractor to the manufacturer on a per diem basis.

C. A mechanical performance test shall be performed prior to the plant being placed into service. Present shall be the engineer and the system suppliers designated representative. The installing contractor shall furnish all labor, materials and equipment required for such tests and shall correct any deficiencies noted by repairing or replacing the defective equipment and completing the testing.

1.11 PROCESS PERFORMANCE

A. The performance of the BIOPROCESS H2O process system shall be guaranteed to produce an effluent which meets the design basis as indicated in Design Criteria and Data for a period of at least one full school year.

1.12 TOWN OF PLYMOUTH AND STATE REQUIREMENTS

A. The Contractor shall notify and make all necessary arrangements with the Town of Plymouth Board of Health and the Commonwealth of Massachusetts, Department of Environmental Protection, Division of Water Pollution Control sufficiently in advance of the installation of the wastewater treatment system for any testing and inspection to occur.

B. All work and materials for the wastewater treatment system installation shall be subject to approval of the Town of Plymouth Board of Health and the Commonwealth of Massachusetts, Department of Environmental Protection, Division of Water Pollution Control.

C. The Contractor shall be responsible for making all arrangements with the Town of Plymouth Board of Health and the Commonwealth of Massachusetts, Department of Environmental Protection, Division of Water Pollution Control and for paying all fees associated with the wastewater treatment system installation, testing and inspection.

D. Comply with the rules, regulations, laws and ordinances of the Town of Plymouth, the Commonwealth of Massachusetts, appropriate agencies of the Commonwealth of Massachusetts, and all other authorities having jurisdiction.

E. Comply with the provisions of the Manual of Accident Prevention in Construction of the Associated General Contractors of America, Inc., and the requirements of the Occupational Safety and Health Administration (OSHA), United States Department of Labor.

F. The Contractor shall procure and pay for all permits and licenses required for the complete work specified herein and shown on the Drawings.

G. Any apparent conflict between the Drawings and Specifications and the applicable codes and regulations shall be referred to the Architect in writing, for resolution before the work is started.

1.13 DESIGN CRITERIA AND DATA

A. The Contractor shall provide and install one new advanced wastewater treatment system on the project, complete with all necessary components, as required by Title V of the State of Massachusetts Environmental Code to treat 22,000 gallons of domestic wastewater from the new school and town building complex each day. The system shall be capable of treating the peak flow from the school with flow equalization tank and shall be capable of operating for extended periods (weekends and vacations) with little or no flow.

B. The system provided shall be designed by the manufacturer to treat influent wastewater with the following characteristics which were obtained from a similar school and should be used in determining the minimum treatment requirements for the advanced treatment system.

Average daily flow = 22,000 gals/day

Influent Strength

BOD_5 .....up to 450 mg/l
TSS .....up to 350 mg/l
TKN .....up to 160 mg/l
Ammonia-N .....up to140 mg/l
Ph (S.U.) ..... 6.5 to 8.5
Min. Temp, degrees C 10

C. The effluent discharge concentrations from the system shall not exceed 30 mg/l BOD_5 and 30 mg/l Total Suspended Solids at any time and a minimum of 85% of the influent BOD_5 and Total Suspended Solids shall be removed from the wastewater. The effluent pH shall not vary more than 0.5 standard units from the influent water supply pH. The total nitrogen concentration in the effluent shall not exceed 10 mg/l at any time and a minimum of 90% of the influent total nitrogen concentration shall be removed from the wastewater. Fecal Coliform shall meet 200 colonies/100ml.

D. All components of the advanced wastewater system shall be supplied by Bio Process H2O, and all components shall be new. Where possible, all components shall be of the same manufacturer. All components shall conform to industry standards and all electrical components shall bear the UL label. The system provided shall have one central control panel to control all functions of the system and to display all operating conditions of the system. No other method of modular treatment will be approved as an equal. The DEP Discharge Permit is based on the equipment specified.

1.14 SUMMARY

A. All reactor operations are controlled from the main control panel (MCP). The mode of operation is manual based on the Wastewater Treatment Plant operator equipment setting. The carbon feed is automatic feed pulsed through the MCP flow meter.

B. Each motor shall be capable of being operated from the main control panel through automatic and manual modes. The automatic mode is for time control to provide even wear on the equipment.

1.15 CONTRACTOR QUALIFICATIONS LICENSE

A. The Contractor installing the wastewater treatment system shall have a minimum of five (5) years experience in work of the type required by this section.

B. All work on the wastewater treatment system shall be performed by a septic system installer licensed and bonded by the Town of Plymouth Board of Health. All work shall comply with the latest federal, state and local requirements and specifications including the latest edition of Title V of the State of Massachusetts Environmental Code. All permit applications must be filed and permits obtained prior to any construction work and all fees must be paid.

C. The installing contractor shall provide documentation that he has experience in installing the selected advanced treatment system and that he has installed at least three (3) similar treatment systems of the type and size (larger than 15,000 GPD) selected for use on the project within the last five (5) years.

1.16 OPERATION AND MAINTENANCE INSTRUCTIONS

A. All equipment manufacturers shall be responsible for supplying written instructions, which shall be sufficiently comprehensive to enable the operator of the equipment to operate and maintain the equipment supplied. Said instructions may assume that the operator is familiar with pumps, motors, piping, and valves, but that he has not previously operated and/or maintained similar equipment.

C. These instructions shall be prepared as a systems manual applicable solely to the equipment supplied by the manufacturer to these specifications, and shall include those devices and equipment supplied by him.

C. The instructions shall include, but no be limited to, the following:

1. Descriptions of and operating instructions for each major component of the equipment supplied.
2. Instructions for operation of the equipment in all intended modes of operation.
3. Instructions for all adjustments which must be performed at initial startup of the equipment, adjustments which must be performed after the replacement of components and adjustments which must be performed in the course of preventive maintenance as specified by the manufacturer.
4. Instructions for the adjustment, calibration, and testing of selected electronic components or assemblies, normally considered replaceable by the manufacturer, whose performance is not ascertainable by visual inspection.
5. Service instructions for major components not manufactured by the equipment manufacturer but which are supplied by him in accordance with these specifications. The incorporation of literature produced by the actual component manufacturer shall be acceptable.
6. Electrical schematic diagram of the completed actual installation as supplied, prepared in accordance with National Machine Tool Builders Association (NMTBA) and Joint Industrial Council (JIC) standards. Schematics shall show, to the extent of authorized repair, motor branch, control, and alarm system circuits, and interconnections among these circuits. Wire numbers shall be shown on the schematic. Schematic diagrams for electronic equipment, the detail parts of

which is not normally repairable by the station operator, need not be included, and shall not be substituted for an overall schematic diagram. Partial schematics, block diagrams, and simplified schematics shall not be provided in lieu of an overall schematic diagram.

D. Operation and maintenance instructions which are limited to a collection of component manufacturer literature without overall operational instructions related to this specific installation shall not be acceptable.

E. Operation and maintenance instructions shall be specific to the equipment supplied in accordance with these specifications. Instruction manuals applicable to many different configurations and which require the operator to selectively read portions of the instructions shall not be acceptable.

F. The operation and maintenance data, when assembled into a complete package, shall meet all of the requirements of the Commonwealth of Massachusetts Department of Environmental Protection for Operation and Maintenance Manuals and the Town of Plymouth Board of Health.

G. Guarantees: In addition to the specific guarantee requirements of the General Conditions, the Contractor shall obtain extended guarantees for materials furnished under this section where such guarantees are offered in the manufacturer's published data. All these guarantees shall be in addition to, and not in lieu of, other liabilities which the Contractor may have by law or other provisions of the Contract Documents.

H. The Contractor shall install a Main Control Panel to serve the entire treatment plant and will also provide and install all field wiring for the Treatment System Main Control Panel.

I. The Contractor shall provide wiring diagrams of all panels and manufacturers' component information as per Section 26 00 00.

J. The Contractor shall obtain from the equipment supplier(s) three (3) copies of operations and maintenance manual for review. These manuals shall contain a complete wiring diagram, internal component location diagram and a complete functional description of panel operation. They shall also include a troubleshooting guide and the telephone number to obtain service.

PART 2 - PRODUCTS

2.1 BIO PROCESS H20 EQUIPMENT PACKAGE (PROPRIETARY PRODUCT)

A. The equipment package from BIOPROCESS will include the following:

Equipment List

Item	P&ID Ref #	Description
Permeate Tank	T-0841	Custom 2,000 Gallon Tank
FET Feed Pumps #1 (1)	P-0111	ABS XFP100C CB1 – 3.75HP
FET Feed Pumps (1)	P-0112	ABS XFP100C CB1 – 3.75HP

Item	P&ID Ref #	Description
EQ Pump #1 (1)	P-0211	Keen Model KG2-23 - 2 HP
EQ Pump #2 (1)	P-0212	Keen Model KG2-23 - 2 HP
Denitrification Pump(1)	P-0511	ABS Model XFP 80C-2.7HP
Membrane Recirc Pump(1)	P-0711	ABS Model XFP 100C-4.7 HP
Permeate Pump #1	P-0811	Goulds 2ST – .5 HP
Permeate Pump #2	P-0812	Goulds 2ST – .5 HP
Backwash Pump #1	P-0911	Goulds 25SH-5HP
Backwash Pump #2	P-0912	Goulds 25SH-5HP
UF System Sump Pump	P-1011	Goulds Model WE05H .5 HP
Permeate Tank (T-0841) UV Recirc Pump	P-0811	Goulds 2ST- .5 HP
Final Effluent Pump #1(1)	P1111	ABS XFP100C CB1- 2.7HP
Final Effluent Pump #2(1)	P1112	ABS XFP100C CB1- 2.7HP
Pre-Anoxic Carbon Metering Pump	P-0311	Walchem Model EWB16
Post Anoxic Carbon Metering Pump	P-0712	Walchem Model EWB16
Aeration Tank Caustic Metering Pump	P-0411	Walchem Model EWB16
UF Membrane Acid CEB Metering Pump	P-0913	Walchem LKN LKN55A
UF Membrane Hypochlorate CEB Metering Pump	P-0914	Walchem Model EHE46
UF Membrane Caustic CEB Metering Pump	P-0915	Walchem Model EHE46
Pre Anoxic Mixer(1)	MI-0351	ABS Model RW3021 -2.7HP
Pre Anoxic Mixer(1)	MI-0651	ABS Model RW3021 -2.7HP
Aeration Tank Mixer(1)	MI-0451	ABS Model RW3021 -2.7HP
Aeration Blower #1	BL-0451	Kaeser Model BB89C - 10HP
Aeration Blower #2	BL-0452	Kaeser Model BB89C - 10HP
Membrane Air Scour Blower	BL-0751	Becker Model: DX 4.40K
Process Air Compressor(3)	CMP-1251	Speedaire Model 4TW29C (to be powered by plant utility panel)
EQ Level Sensor	LS-0221	Mecoid Series PBLT2 & PBL TX

Item	P&ID Ref #	Description
Post Anoxic Tank Level Sensor	LS-0621	Mecoid Series PBLT2 & PBL TX
Permeate Tank Level Sensor	LS-0825	Dwyer Industrial Pressure Transmitter 626-07-CH-P1-E5-S1 (0-15 psi)
Final Effluent Tank Level Sensor	LS-1121	Mecoid Series PBLT2 & PBL TX
Bar Screen Float(3)	LSL-0223	Connery
Membrane Sump Floats(3)	LSL-1021, LSH-1022, LSH-1023	Connery
UF Capacitance Switch (Level)	LS-0724	Vibex Model LSV1-01-06-N-C
UF Membrane Feed Pressure Transmitter(3)	PG-0722	Wika S20
UF Membrane Permeate Pressure Transmitter(3)	PG-0822	Wika S20
Compressed Air Pressure Transmitter(3)	PT-1221	Wika S20
Dissolved Oxygen Meter(3)	AIC-0422	Hach - Part#: LXV404.99.00552 SC200 Controller, AC-DC, 2 DIG
Dissolved Oxygen Probe(3)	DO-0422	Hach - Part#: 9020000 ASSY, Probe, LDO Model 2, 10M
UF Temperature Transmitter(3)	TE-0723	Dwyer TTE-106-W
EQ Flow Meter(3)	FM-0222	Siemens mag 5000 / 5100W-2”
Membrane Recirc Flow Meter(3)	FM-0721	Siemens mag 5000 / 5100W-6”
Membrane Permeate Flow Meter(3)	FM-0823	Siemens mag 5000 / 5100W-1.5”
Membrane Backwash Flow Meter(3)	FM-0921	Siemens mag 5000 / 5100W-3”
Denitrification Pump Flow Meter(3)	FM-0521	Siemens mag 5000 / 5100W-3”
Dosing Pump #1 Flow Meter(3)	FM-1125	Siemens mag 5000 / 5100W-4”
Dosing Pump #2 Flow Meter(3)	FM-1127	Siemens mag 5000 / 5100W-

Item	P&ID Ref #	Description
		4”
UF Membrane Air Flow Switch(3)	FS-0725	Kobold Model KAL-8115
Aeration pH Controller & UF Membrane pH Meter(3)	AIC-0421	Walchem Model WDP420-5-2
Pre/Post Anoxic ORP Controller(3)	AIC-0321	Walchem Model WDP420-5-2
Final Effluent pH Meter(3)	AI-1126	Walchem Model WPH410-5-2
pH Probes (for aeration)	Incl w/controller	Walchem WEL-PHF-21
ORP Probes (for Pre and Post Anoxic and RO) (3)	Incl w/controller	Walchem WEL-MVR-2
pH Probes (for Final Effluent) (3)	Incl w/controller	Sensorex S675 PH
Turbidity Meter	TM-0824	Hach SC100-1720E
UF Membranes	UF-0701,0702,0703	Norit Xflow Model 38PRV-XLT – Custom Membrane
Aeration Tank Aeration System(3)	AE-0451	EDI Model Flexair 84P Magnum
Influent Fine Screen(3)	SC-0251	Comminuter Service Model FS600S-2MM
UF System UV Unit(3)	UV-0851	Aqua Azul Model AAGI-50
Permeate Tank UV Unit(3)	UV-0852	Aqua Azul Model AAGI-50
Odor Control Skid(3)	B-1251	General Carbon Model ES-42-1
UF Membrane Feed Valve(2)	AV-0733	6” Butterfly
UF Membrane Bypass Valve(2)	AV-0735	3” Ball
UF Membrane De-Aeration Valve(2)	AV-0736	2” Ball
UF Membrane Return Valve(2)	AV-0737	6” Butterfly
UF Membrane Air Scour Valve(2)	AV-0738	1” Ball
UF Membrane Permeate Valve(2)	AV-0831	3” Ball
UF Membrane BW Bypass Valve(2)	AV-0937	3” Ball
UF Membrane Backwash Valve	AV-0938	3” Ball
UF Membrane Aeration BW Valve(2)	AV-0939	1” Ball
UF Membrane Turbidity Valve(2)	SV-08	¼ “ Solenoid

Item	P&ID Ref #	Description
Main Control Panel		Custom Panel

(1) The BioProcess pump package does not include stainless steel rails and chains where shown. To be provided by WWTP contractor.

(2) Actuated valves will be Jomar or equal. All actuators to be single acting with open/close limit switches and indicating beacon. Actuators to have open and close speed adjustment. All valves to be schedule 80 PVC true union except for AV-0738 which is schedule 80 Dura Plus. Butterfly valves to be cast iron body, EPDM seats with nylon coated discs.

(3) Equipment as noted or equal.

2.2 SPARE PARTS

The following spare parts are included:

- Bar Screen Motor
- Pre/Aeration/ Post Anoxic Mixer (quantity 1)
- Membrane Permeate Pump / UV Recirc Pump (quantity 1)
- Membrane Recirc Pump
- Membrane Drain Sump Pump
- Membrane Air Scour Blower
- Air Compressor
- Chemical Metering Pump Repair Kit for each style pump
- pH Probe
- ORP Probe
- UV Lamp (4)

2.3 PROTECTION AGAINST CORROSION AND ABRASION

A. After welding, all steel surfaces shall be blasted to remove rust, mill scale, weld slag. All weld spatter and surface roughness shall be removed by grinding. Following cleaning, a single heavy inert coating shall be applied to all surfaces. This coating shall be epoxy resin especially formulated for abrasion and corrosion resistance. The dry coating shall be a minimum of 6 mils thickness.

B. All stainless steel, aluminum and other corrosion-resistant surfaces shall not be coated.

C. A touch-up kit shall be provided for repair of all scratches or mars occurring during installation. This kit shall contain detailed instructions for use and shall be a material, which is compatible with the original coatings.

2.4 ELECTRICAL CONTROLS

A. The electrical components shall be furnished by the manufacturer of the modules in a NEMA 4 rain-tight cabinet. The cabinet shall be mounted by the contractor inside the control building. A separate thermal magnetic circuit breaker and magnetic contactor shall be furnished for each blower motor. The blower starter shall be controlled by a selector switch. Starters for 3-phase circuits shall have overload and under voltage release protection on each conductor. Wiring in the control cabinet shall be color-coded and shall be in accordance with the National Electrical Code.

B. All conduit and wiring between the electrical control panel enclosure and motors furnished with the treatment plant and between the panel and the power utility pole shall be furnished and installed by the contractor.

C. The Main Control Panel to be provided by BIOPROCESS will include provisions to allow connections for Supervisory Control and Data Acquisition (SCADA). IT connection to new WWTP to be provided by Contractor.

2.5 INSTALLATION AND OPERATING INSTRUCTIONS

A. Installation of the BIOPROCESS H-20 treatment system shall be done in accordance with the instructions provided by the Manufacturer and shown on the drawings.

B. Operation and maintenance manuals shall be furnished which will include a description of operation and upkeep procedures.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor is referred to the Contract Drawings and specifications for all items whether or not specifically described herein. It is intended that all manufactured devices, systems, equipment and other items described and specified in this section shall be furnished by this section except as otherwise noted. Installation shall be by this section except as otherwise noted.

3.2 EQUIPMENT INSTALLATION

A. Installation by the purchasing contractor shall be in strict accordance with the BIOPROCESS H2O process system manufacturer's instructions and recommendations.

3.3 EQUIPMENT WARRANTY (REQUIRED BY THE TOWN OF PLYMOUTH)

A. All equipment and installation provided under this section requires a minimum of a two year warranty including but not limited to all proprietary wastewater equipment and products provided by BIOPROCESS H20. (**CRITICAL)**

3.4 DECOMMISSIONING AND REMOVAL OF EXISTING OLD WWTP

Portions of the existing WWTP equipment and piping must be removed at all locations shown on the contract drawings. All asbestos, if present, must be removed in accordance with DEP regulations prior to actual demolition of the retired WWTP equipment and piping.

A. All tankage and piping inside the existing WWTP building to be cut, dismantled, crushed and removed from the site to a legal disposal area or salvaged.

B. Outside Sludge Holding Tank to be pumped of sewage solids and liquids by a licensed Septage Hauler and properly disposed of at a DEP approved receiving station. Underground Tank to be opened/ruptured at bottom to prevent retainage of water and the tank completely filled with compacted clean sand covered to grade to match surrounding pavement.

C. All stored chemicals within the site related to the former WWTP shall be removed and relocated to an approved location. Related tankage and appurtenances shall be cleaned/purged and disposed as legally appropriate.

D. All wastewater piping currently conveying waste into the WWTP inside building treatment process as well as discharging to final leach areas, five feet outside of the existing WWTP building, shall be flushed of liquid and solids and properly disposed and removed from the site to an approved location or removing portions of the underground pipe and back filling with concrete to make the pipe unsuitable for future use. Liquids/solids generated by the flushing shall be pumped by a licensed Septage Hauler and disposed of properly. All cut sewer lines to be capped or sealed after flushing.

E. All other utilities related to the existing WWTP such as, but not limited to potable water connection, gas connection, electric connections, to WWTP equipment shall be abandoned or removed in accordance with the State or local regulations.

F. All equipment/tanks piping, electrical process connections shall be completely removed within the scope of this task.

G. Reconstruction of the existing WWTP floor is not included within this scope. However, the lower floor elevations must be provided with temporary safety fence or barrier to prevent injury.

H. DEP requires within one hundred and twenty (120) days, an as-built site plan by the Contractor be prepared to accurately label and show locations of all components of the former treatment plant that were decommissioned. Contractor to add notes to the plan to signify which pipes or components were abandoned on site (if any) and how they were abandoned. This as-built plan to be stamped by a MA Registered Professional Engineer and submitted to DEP and Plymouth Board of Health.

3.5 MISCELLANEOUS

A. The Contractor shall furnish and install the following materials as specified by this section and/or the contract drawings:

1. In addition to the above-mentioned items, the Contractor shall furnish and install (if applicable) any and all appurtenant items necessary to make the treatment plant fully operable in accordance with the approved Drawings and Specifications.

END OF SECTION

Section 46 07 13

PACKAGED WATER TREATMENT EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 REFERENCES

A. All work specified in this Section shall conform to the Town of Plymouth standards.

B. All work specified in this Section shall confirm to the MassDEP BRP 23A "Approval to Construct a Water Treatment Facility" permit issued for this project as well as applicable MassDEP public water system regulations.

C. American Water Works Association (AWWA):

1. AWWA B100: Standard for Granular Filter Media
2. AWWA B550: Standard for Calcium Chloride.

D. American National Standards Institute/National Sanitation Foundation:

1. ANSI/NSF 60: Drinking Water Treatment Chemicals – Health Effects.

1.3 SUMMARY

A. This Section specifies requirements for furnishing and installing water treatment system components in the new school building. The intent of the new treatment system is to raise the pH of potable water to 8.0 – 9.0 for corrosion control associated with the interior piping in the new school. The pH of raw water at the site is approximately 6.0 – 6.5.

B. The Plumbing Subcontractor shall pay for all costs and fees related to the construction of the new water treatment system including all inspection fees and shall file all applications, details, and drawings required by MassDEP and the local authority having jurisdiction.

C. Plumbing Subcontractor is made aware of the fact the water system at the site constitutes a public water system regulated by the MassDEP. The work specified in this section is subject to the requirements of the BRP 23A "Approval to Construct a Water Treatment Facility" permit issued by MassDEP. Modifications to the water distribution system in general are subject to the BRP 33 "Distribution System Modifications" permit also issued by MassDEP.

1.4 SUBMITTALS

A. Product Data and Shop Drawings: For each type of product indicated. Submitted and approved by the Architect and the Town of Plymouth.

B. Field quality-control test reports and disinfection notification: The Plumbing Subcontractor shall initially notify and subsequently provide the test reports to the Town of Plymouth upon completion of the disinfection and pressure testing.

C. Operation and Maintenance (O&M) Manuals: Plumbing Subcontractor shall provide Owner with Operation and Maintenance Manuals for the installed equipment, as appropriate and available, to be incorporated into a final O&M Manual for the treatment facility.

D. A copy of any permits required by local authorities having jurisdiction shall be submitted to the Owner prior to commencing work on the water system.

E. Certificate of Compliance:

1. Each shipment of equipment and materials shall be accompanied with the manufacturer's notarized certificate certifying conformance with the requirements of the Specifications.

1.5 PERMIT

A. The Plumbing Subcontractor shall maintain copies of the BRP 23A "Approval to Construct a Water Treatment Facility" and BRP 33 "Distribution System Modifications" permits issued by the MassDEP at the site at all times during performance of the work specified.

B. The Plumbing Subcontractor shall setup a Preconstruction Meeting with the Town of Plymouth to finalize approval of layout and details by The Town of Plymouth prior to commencing work.

C. The Plumbing Subcontractor shall obtain all permits required to perform work on the water system without expense to the Owner.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with applicable requirements of the Town of Plymouth including requirements pertaining to the tapping of water mains and backflow prevention.
2. Comply with applicable Town of Plymouth standards for potable-water-service piping, including materials, installation, testing, and disinfection.
3. Comply with MADEP requirements for water treatment systems.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. All treatment system components shall be "American Made".

1.7 DELIVERY, STORAGE, AND HANDLING

A. All delivery, storage, and handling of materials and equipment shall be in accordance with manufacturer's recommendations.

1.8 COORDINATION

A. The Plumbing Subcontractor shall coordinate with the Town of Plymouth prior to commencing any work on the water system to verify treatment system layout.

B. The installed work will be subject to a final inspection by representatives of the MADEP Drinking Water Program.

1.9 MANUFACTURER'S REPRESENTATIVE

A. The Plumbing Subcontractor shall furnish at no additional expense to the Owner, the services of manufacturer's representatives, as appropriate, for installation of treatment system components, including tanks and treatment media. The instruction shall include proper handling and installation and shall be for such lengths of time required to fully familiarize the Plumbing Subcontractor's personnel with the proper techniques. At a minimum, Plumbing Subcontractor shall engage the services of manufacturer’s representative to oversee and perform treatment system setup and testing.

PART 2 - PRODUCTS

2.1 GENERAL

A. All water treatment equipment, materials, and appurtenances are to be American made.

B. All materials shall be reviewed and approved prior to installation by the Town of Plymouth.

C. Equipment, materials, and products deviating from those specifically approved by the MassDEP shall require MassDEP review and approval. The Plumbing Subcontractor shall provide adequate lead time for this review and approval.

D. Equipment, materials, and products ordered or purchased prior to obtaining all required approvals is done so at Plumbing Subcontractor’s own risk with no expense to Owner.

2.2 CALCITE TREATMENT MEDIA

A. Calcite media shall be OZ White NSF by Imerys Performance Materials.

B. An alternate treatment media may be considered for use only after review and approval by Engineer, Town of Plymouth, and MassDEP, in accordance with the requirements of the BRP 23A permit issued for this project.

2.3 FILTRATION MEDIA

A. Coarse filtration media shall be 1/4-inch by 1/8-inch gravel media.

B. Fine filtration media shall be Flint #20, 1/8-inch by 1/16-inch gravel media.

C. Filtration media shall meet AWWA B100 and NSF 60 standards.

D. Filtration media shall be double washed at its place of manufacture for the removal of clay, shale, and inorganic impurities.

E. Filtration media shall be by Fairmount Santrol – Best Sand Corporation or approved equal.

2.4 PRESSURE VESSEL

A. Each pressure vessel housing treatment media and bedding shall be 30 inches in diameter and 72 inches tall and shall be installed with 30-inch tripod base.

B. Structural composite vessels shall be of polyethylene construction and rated to a maximum operating pressure of 150 psi. They shall be approved for use in potable water applications in accordance with AWWA and NSF requirements.

C. Pressure vessels shall be fitted with threaded adapters to permit inlet and outlet piping through top of vessel.

D. Pressure vessels and base shall be manufactured by Pentair Water or approved equal.

2.5 APPURTENANCES

A. In-line digital pH analyzers for raw water and treated water shall be manufactured by HACH, or approved equal, and shall be suitable for use with potable water.

B. Digital pH analyzers shall connect to a wall-mounted dual channel controller and display the pH of raw water and treated water. Controller to be HACH sc200 or approved equal.

C. Flow control valve shall be installed on inlet to each tank to restrict flow to a maximum 30 gpm. Flow control valve to be Clack Model 3080, or approved equivalent.

D. Piping within treatment vessel shall be Class 200 PVC with outlet at bottom of tank within gravel bedding layer.

E. Piping, valves, water meter, and appurtenances not specifically described herein are described in the plumbing details and specifications of this Contract.

2.6 STORAGE OF EQUIPMENT AND MATERIALS

A. Equipment and materials shall be stored in locations and in a manner approved by the Engineer and manufacturer's representative. The locations and manner of storage shall be as to minimize handling of the materials.

B. The Plumbing Subcontractor shall, at all times, be solely responsible for the safe storage of all materials.

PART 3 - EXECUTION

3.1 GENERAL

A. The Plumbing Subcontractor shall be responsible for the coordination of all trades and work described in other sections which are involved in completing the installation of the water treatment system. This shall include the complete compatibility of electrical and mechanical components as necessary.

B. Equipment shall be installed to accurate grades and lines and all interconnections shall be as straight and direct as possible while still providing the least work necessary to disconnect and replace equipment as quickly as possible. Any

condition the Plumbing Subcontractor encounters that will hinder rapid replacement of equipment shall be brought to the attention of the Engineer for his direction.

C. The manufacturer(s) shall verify that all components have been sampled, tested and inspected, as applicable, in accordance with these specifications and that they meet all requirements specified herein.

3.2 INSTALLATION

A. All materials and equipment shall be installed in a safe, neat, workmanlike manner.

B. Installation of tanks shall be in accordance with written instructions provided by the manufacturer.

C. Drawings show piping, valves, fittings, and accessories diagrammatically, and do not show dimensions or all required appurtenances.

1. The Plumbing Subcontractor must submit for approval, all piping shop drawings which shall indicate all locations and details for piping, valves, fittings, supports, and appurtenances; at which time, the Plumbing Subcontractor shall bring to the Engineer's attention any conflict with his work or the work of other trades.
2. Any changes required to fit the piping work to equipment or structures shall be approved and shall be performed at no additional expense to the Owner.

D. Pipe, fittings, valves, accessories, and connections to equipment shall be installed in accordance with the drawings and specifications, the approved piping shop drawings, and in strict accordance with the manufacturer's recommendations.

1. All equipment and materials shall be new and unused, unless otherwise specified.
2. Suitable tools and equipment shall be used for the safe and proper installation of all items.
3. Equipment shall be set accurately and firmly secured.

E. The Plumbing Subcontractor shall inspect all equipment and associated items for defects before installation and all defective items shall be replaced with new, approved material at no additional expense to the Owner.

F. All pipe fittings and accessories shall be cleaned inside before installation.

G. Adequate supports, hangers, tie-down straps, and retaining anchors shall be provided to properly restrain and support all piping, equipment and accessories as necessary. Size, type and method of installation of anchoring and support devices shall be in strict accordance with manufacturer’s requirement.

H. Calcite and gravel filtration media shall be installed in each tank in the field during tank installation and system setup. Media shall be poured from new, unopened bags into each tank through a clean, appropriately-sized funnel, per manufacturer’s requirements. Plumbing Subcontractor shall take all recommended safety

precautions during installation and setup (e.g., necessary precautions to prevent worker's inhalation of dust).

I. All installation of equipment and appurtenances shall be performed by workmen skilled in this type of work and in a manner to ensure proper positioning, alignment and satisfactory operation of all equipment without undue stresses or vibration.

J. The installation of the equipment shall be performed under the supervision of qualified representatives of the equipment manufacturer(s).

3.3 SYSTEM STARTUP

A. Plumbing Subcontractor shall procure the services of the manufacturer's local representative to perform system startup to ensure proper operation, such that:

1. pH analyzers are reading accurately and the controller clearly displays the pH of both raw water and treated water;
2. flow control valves are working adequately where the maximum flow rate is restricted to 30 gpm; and
3. there is no carryover of calcite treatment media out of the vessel.

3.4 CLEAN UP

A. Prior to start-up and field testing, all foreign matter shall be removed from all new equipment. Spillage of lubricants used in servicing the system shall be cleaned from all equipment and concrete surfaces.

B. After completion of the work all piping and appurtenances shall be thoroughly cleaned inside and out and all valves shall be opened and closed to assure proper operation.

END OF SECTION

APPENDIX A

MASTER KEYNOTE LIST

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DIVISION 00 - BIDDING AND CONTRACT REQUIREMENTS

00 01 01 NOT USED

00 01 01.01 NOT USED

DIVISION 01 - GENERAL REQUIREMENTS

01 00 01 NOT USED

01 00 01.01 NOT USED

DIVISION 02 - EXISTING CONDITIONS

02 00 01 NOT USED

02 00 01.01 NOT USED

DIVISION 03 - CONCRETE

03 05 13 CONCRETE SEALERS

03 05 13.01 CONCRETE SEALER
03 05 13.02 PRIMER

03 30 00 CAST-IN-PLACE CONCRETE

03 30 00.01 CONCRETE
03 30 00.02 CONCRETE SLAB ON GRADE - SEE STRUCTURAL
03 30 00.03 CONCRETE SLAB ON DECK - SEE STRUCTURAL
03 30 00.04 CONCRETE FOOTING - SEE STRUCTURAL
03 30 00.05 CONCRETE FOUNDATION - SEE STRUCTURAL
03 30 00.06 CONCRETE WALL - SEE STRUCTURAL
03 30 00.07 CONCRETE PIER - SEE STRUCTURAL
03 30 00.08 CONCRETE PAD - SEE STRUCTURAL
03 30 00.11 EXPANDABLE JOINT FILLER
03 30 00.12 NORMAL WEIGHT CONCRETE - SEE STRUCTURAL
03 30 00.21 SAW CUT JOINT

03 35 10 POLISHED CONCRETE FINISHING

03 35 10.01 POLISHED CONCRETE

03 45 00 PRECAST ARCHITECTURAL CONCRETE

03 45 00.01 ARCHITECTURAL PRECAST CONCRETE UNIT
03 45 00.02 GALVANIZED STEEL SUPPORT DEVICES

DIVISION 04 - MASONRY

04 20 00 UNIT MASONRY

04 20 00.01 FACE BRICK
04 20 00.05 FACE BRICK - SOLID UNIT
04 20 00.09 FACE BRICK - LIPPED - REFERENCE ELEVATIONS FOR TYPE AND COURSING

04 20 00.11 CMU TYPE SF1 - SPLIT FACE CMU - REFERENCE DRAWINGS FOR BLOCK DEPTH
04 20 00.12 CMU TYPE SF2 - SPLIT FACE CMU - REFERENCE DRAWINGS FOR BLOCK DEPTH

04 20 00.15 SPLIT FACE CMU - UNIVERSAL L CORNER

04 20 00.21 CMU TYPE GF1 - GROUND FACE CMU - REFERENCE DRAWINGS FOR BLOCK DEPTH
04 20 00.22 CMU TYPE GF2 - GROUND FACE CMU - REFERENCE DRAWINGS FOR BLOCK DEPTH
04 20 00.23 CMU TYPE GF3 - GROUND FACE CMU - REFERENCE DRAWINGS FOR BLOCK DEPTH

04 20 00.25 GROUND FACE CMU - UNIVERSAL L CORNER
04 20 00.26 GROUND FACE CMU - SOAP

04 20 00.30 CMU - STANDARD - NORMAL WEIGHT - REFERENCE DRAWINGS FOR DEPTH SIZE AND FIRE RATING
04 20 00.31 CMU BOND BEAM - SEE STRUCTURAL

04 20 00.40 FACE BRICK - REFERENCE ELEVATIONS FOR TYPE AND COURSING
04 20 00.41 FACE BRICK - SOLID UNIT - REFERENCE ELEVATIONS FOR TYPE AND COURSING
04 20 00.42 SPLIT FACE CMU - REFERENCE ELEVATIONS FOR TYPE AND COURSING
04 20 00.43 GROUND FACE CMU - REFERENCE ELEVATIONS FOR TYPE AND COURSING

04 20 00.50 MASONRY MORTAR
04 20 00.51 GROUT FILL

04 20 00.61 TYPICAL MASONRY ANCHOR/TIES - REFERENCE SPECIFICATION FOR SPACING
04 20 00.62 HORIZONTAL MASONRY REINFORCING- GALVANIZED TRUSS TYPE
04 20 00.63 COMPRESSIBLE FILLER AT TOP OF MASONRY PARTITIONS AND EXPANSION JOINTS
04 20 00.64 SEALANT - TYPE AS REQUIRED
04 20 00.65 15# BUILDING FELT
04 20 00.66 WEEP HOLES - 24 INCHES O.C.

04 20 00.67 MORTAR NET
04 20 00.68 PREMOLDED FLEXIBLE DRIP EDGE - THE DRIP EDGE SHALL EXTEND BEYOND THE FACE OF FACE OF BRICK, TYPIC/
04 20 00.69 AIR SPACE - MAINTAIN CLEAR OF MORTAR
04 20 00.70 PREMOLDED CONTROL JOINT

04 20 00.80 AIR/VAPOR BARRIER TRANSITION MEMBRANE - SELF ADHERING

DIVISION 05 - METALS

05 12 00 STRUCTURAL STEEL FRAMING

05 12 00.01 STEEL BEAM - SEE STRUCTURAL
05 12 00.02 STEEL COLUMN - SEE STRUCTURAL
05 12 00.06 STEEL TUBE - SEE STRUCTURAL
05 12 00.08 STEEL TUBE COLUMN - SEE STRUCTURAL
05 12 00.10 STEEL OUTRIGGER - SEE STRUCTURAL
05 12 00.11 STEEL TUBE OUTRIGGER - SEE STRUCTURAL
05 12 00.14 STEEL TRUSS - SEE STRUCTURAL
05 12 00.16 STEEL CHANNEL - SEE STRUCTURAL
05 12 00.17 STEEL CHANNEL STRINGER - SEE STRUCTURAL
05 12 00.18 STEEL ANGLE CONTINUOUS - SEE STRUCTURAL
05 12 00.19 STEEL TUBE STRINGER - SEE STRUCTURAL
05 12 00.20 STEEL RELIEVING ANGLE - SEE STRUCTURAL
05 12 00.32 STEEL PLATE - SEE STRUCTURAL
05 12 00.36 STEEL PLATE BENT - SEE STRUCTURAL
05 12 00.40 BRACE FRAME - SEE STRUCTURAL
05 12 00.41 SUSPENDED STEEL LINTEL ASSEMBLY - AS OCCURS - SEE STRUCTURAL
05 12 00.50 STEEL HOIST BEAM - SEE STRUCTURAL

05 15 00 STUD SHEAR CONNECTORS

05 15 00.01 STEEL SHEAR STUD CONNECTORS - SEE STRUCTURAL

05 31 00 STEEL DECKING

05 31 00.01 COMPOSITE STEEL DECK - SEE STRUCTURAL
05 31 00.02 POUR STOP - FLOOR SLAB - SEE STRUCTURAL
05 31 00.03 STEEL FORM DECK - SEE STRUCTURAL
05 31 00.10 STEEL ROOF DECK - 1 1/2 INCH GALVANIZED - SEE STRUCTURAL
05 31 00.11 STEEL ROOF DECK - 3 INCH GALVANIZED - SEE STRUCTURAL
05 31 00.12 STEEL ROOF DECK - 3 INCH CELLULAR ACOUSTICAL DECK - SEE STRUCTURAL
05 31 00.20 CONTINUOUS STEEL DECK CLOSURE - SEE STRUCTURAL

05 40 00 COLD FORMED METAL FRAMING

05 40 00.01 STEEL STUDS - 1 5/8 INCH - 16 INCHES O.C. MAX
05 40 00.02 STEEL STUDS - 2 1/2 INCH - 16 INCHES O.C. MAX
05 40 00.03 STEEL STUDS - 3 5/8 INCH - 16 INCHES O.C. MAX
05 40 00.04 STEEL STUDS - 4 INCH - 16 INCHES O.C. MAX
05 40 00.05 STEEL STUDS - 5 INCH - 16 INCHES O.C. MAX
05 40 00.06 STEEL STUDS - 6 INCH - 16 INCHES O.C. MAX
05 40 00.08 STEEL STUDS - 8 INCH - 16 INCHES O.C. MAX
05 40 00.10 STEEL STUDS - 10 INCH - 16 INCHES O.C. MAX
05 40 00.11 STEEL STUDS - 11 INCH - 16 INCHES O.C. MAX
05 40 00.12 STEEL STUDS - 12 INCH - 16 INCHES O.C. MAX

05 40 00.17 STEEL Z-CLIP - 16 INCHES O.C. MAX
05 40 00.18 STEEL Z-CLIP - 3 INCH - 16 INCHES O.C. MAX
05 40 00.19 STEEL Z-CLIP - 16 GAGE MIN. - 2 INCH MIN. DEPTH - 16 INCHES O.C. MAX

05 40 00.21 ISOLATION HANGER
05 40 00.22 NEOPRENE PAD
05 40 00.23 METAL CEILING HANGER - ENGINEERED TO SUPPORT CEILING SYSTEM

05 40 00.25 METAL FURRING - 7/8 INCH

05 40 00.30 STEEL BRACE AS REQUIRED

05 40 00.40 DOUBLE STUD AT JAMB- SIZE AS REQUIRED
05 40 00.41 STEEL STUD & TRACK - BOXED HEADER
05 40 00.42 STEEL BUILT-UP COLUMN

05 40 00.55 14 GAGE BENT GALVANIZED STEEL PLATE - SECURE TO STRUCTURAL MEMBER AS REQUIRED - SIZE AS NOTED OR
05 40 00.56 LIGHT GAGE BENT PLATE - SIZE AS REQUIRED

05 40 00.60 DOUBLE STEEL STUD CLEAT - 10 INCH - CONTINUOUS
05 40 00.61 DOUBLE STEEL STUD CLEAT - 4 INCH - CONTINUOUS

05 40 00.70 STEEL RAFTER - 6 INCH

05 50 00 METAL FABRICATIONS

05 50 00.01 STEEL ANGLE - 5 x 3-1/2 x 3/8 LLV - CONTINUOUS - 1/2 INCH DIA SLOTTED HOLES
@ EACH LEG STAGGERED / BOLTED TO ANGLE - BLOCKING HOLES @ 32 INCHES O.C.
05 50 00.02 STEEL ANGLE - 8 x 4 x 1/2 LLH - CONTINUOUS - 1/2 INCH DIA SLOTTED HOLES
@ EACH LEG STAGGERED / BOLTED TO ANGLE - BLOCKING HOLES @ 32 INCHES O.C.
05 50 00.03 STEEL ANGLE - 8 x 8 x 1/2 - CONTINUOUS - PROVIDE WELDING HOLES IN HORIZONTAL LEG
@ VERTICAL LEG STAGGERED FOR WOOD BLOCKING BOLTED CONNECTION

05 50 00.04 STEEL BENT PLATE - 14 x 10 x 5/16 LLH - CONTINUOUS - PROVIDE WELDING HOLES IN HORIZONTAL LEG
@ 16 INCHES O.C. - WELD TO STRUCTURAL STEEL - 1/2 INCH DIA SLOTTED HOLES VERTICAL LEG @ 3
05 50 00.05 STEEL ANGLE - 10 x 8 x 1/2 LLH - CONTINUOUS - PROVIDE WELDING HOLES IN HORIZONTAL LEG

05 50 00.10 STEEL ANGLE - SEISMIC CLIP - SEE STRUCTURAL
05 50 00.11 STEEL ANGLE - SUPPORT FOR ELEVATOR SILL - SIZE AS REQUIRED
05 50 00.12 STEEL ANGLE - SEE STRUCTURAL
05 50 00.13 STEEL ANGLE - ACOUSTIC CLOUD SUPPORT - 4 x 3 x 3/8
05 50 00.14 STEEL ANGLE - 2 x 2 x 1/4
05 50 00.15 STEEL ANGLE - 3 x 3 x 1/4
05 50 00.16 STEEL ANGLE - 4 x 4 x 1/4
05 50 00.17 STEEL ANGLE - 2-1/2 x 2-1/2 x 1/4, 12 INCHES IN LENGTH, WELDED TO BOTTOM OF TRUSS CHORD. COORDINATE LO
05 50 00.18 STEEL ANGLE - 3 x 3 x 3/8 - STUDENT DINING CANOPY
05 50 00.19 STEEL ANGLE CONTINUOUS - SIZE AS NOTED OR DRAWN

05 50 00.21 STEEL TUBE - SEE STRUCTURAL
05 50 00.22 STEEL BEAM - SEE STRUCTURAL

05 50 00.31 STEEL CHANNEL - ROOF OPENING - SEE STRUCTURAL
05 50 00.32 STEEL CHANNEL - ACOUSTIC CLOUD SUPPORT - C3x6
05 50 00.33 STEEL CHANNEL - C15x50

05 50 00.35 STEEL RING - 3 INCH DIAMETER

05 50 00.40 STEEL PLATE - 20 GAGE - SECURE TO EACH STUD
05 50 00.41 STEEL PLATE - 1/4 INCH THICK
05 50 00.42 STEEL PLATE - 3/8 INCH THICK
05 50 00.43 STEEL PLATE - 1/4 INCH THICK, 12 INCHES IN LENGTH. COORDINATE HEIGHT OF PLATE, LOCATIONS AND QUANTITY
05 50 00.44 STEEL BENT PLATE - SEE STRUCTURAL
05 50 00.45 STEEL PLATE - 1/2 INCH THICK
05 50 00.46 STEEL BENT PLATE - 6 x 6 x 3/8
05 50 00.47 STEEL PLATE - 5/16 INCH THICK
05 50 00.48 STEEL PLATE 5/8 INCH THICK
05 50 00.49 STEEL BENT PLATE - 1/4 INCH THICK

05 50 00.50 STAINLESS STEEL SUNSHADE SUPPORT KICKER
05 50 00.51 STEEL ANGLE LINTEL - REFERENCE STRUCTURAL STEEL SCHEDULE
05 50 00.52 STEEL ANGLE LINTEL - 8 x 4 x 7/16 LLH
05 50 00.53 STEEL LINTEL - W16x26
05 50 00.54 STEEL WT4x5 - SCIENCE HANGER DETAIL
05 50 00.55 STEEL WT4x7.5
05 50 00.56 STAINLESS STEEL KNIFE PLATE
05 50 00.57 STAINLESS STEEL EYEBOLT
05 50 00.58 STAINLESS STEEL BAR - WOVEN IN FABRIC
05 50 00.59 STAINLESS STEEL FABRIC - ETCHED WITH GRAPHIC

05 50 00.60 SHOP APPLIED COLOR COATING
05 50 00.61 STEEL TRIANGLE SUPPORT BRACKET - 2 INCH WIDE x 1/4 INCH THICK @ 18 INCHES O.C. MAX
PREDRILLED INSTALLATION @ FASTENING HOLES
05 50 00.62 STEEL ANGLE - 2 x 1 1/2 WITH WELDED CORNERS - PROJECTOR LIFT
05 50 00.63 THREADED ROD - 1/2 DIAMETER - PROJECTOR LIFT
05 50 00.64 BOLT AND WASHER EACH SIDE - PROJECTOR LIFT
05 50 00.65 BAR GRATING - PLAIN STEEL - CLOSE MESH

05 50 00.70 STAINLESS STEEL CLEVIS - NUMBER 3
05 50 00.71 STAINLESS STEEL ROD - 1 INCH DIAMETER
05 50 00.72 STAINLESS STEEL PLATE - 1/2 INCH THICK
05 50 00.73 STAINLESS STEEL TURNBUCKLE - HEX BAR

05 50 00.75 2 INCH X 2 INCH STEEL CHANNEL
05 50 00.76 5 INCH X 2 INCH STEEL CHANNEL
05 50 00.77 1 1/2 INCH X 1 1/2 INCH STEEL ANGLE
05 50 00.78 STEEL FASTENERS

05 50 00.80 THREADED POST - 1/4 INCH DIAMETER - WELDED TO LETTER
05 50 00.81 ANCHOR BOLT
05 50 00.82 EXPANSION BOLT
05 50 00.83 STEEL LETTERS - 10 INCH FIRST LETTER - 8 INCH TYPICAL
05 50 00.84 THREADED ROD
05 50 00.85 ALUMINUM PLATE GRILLE - 3/16 INCH THICK - BRUSHED ALUMINUM FINISH
05 50 00.86 ALUMINUM INFILL PANEL - TYPE 1
05 50 00.87 ALUMINUM INFILL PANEL - TYPE 2

05 50 00.91 STEEL BOLLARD - INSTALLED BY SITE CONTRACTOR
05 50 00.92 ELEVATOR PIT LADDER
05 50 00.93 ROOF ACCESS LADDER - INTERIOR
05 50 00.94 ROOF ACCESS LADDER - EXTERIOR
05 50 00.95 ROOF ACCESS LADDER CAGE
05 50 00.96 ACCESS LADDER - SHOP MEZZANINE
05 50 00.97 CROSSOVER BRIDGE - COORDINATE SIZE WITH MECHANICAL CONTRACTOR TO CLEAR DUCT
05 50 00.99 SHIPS LADDER

05 51 00 METAL STAIRS AND RAILINGS

05 51 00.01 STEEL PAN TREAD AND RISER
05 51 00.02 STEEL PAN LANDING
05 51 00.03 STEEL CHANNEL STRINGER
05 51 00.04 STEEL CHANNEL HEADER
05 51 00.05 STEEL CLOSURE PLATE - WELDED AND GROUND SMOOTH

05 51 00.06 STEEL TUBE LANDING BEAM
05 51 00.07 STEEL TUBE STRINGER

05 51 00.10 STEEL ANGLE CONTINUOUS
05 51 00.11 STEEL ANGLE CLIP
05 51 00.12 STEEL ANGLE CARRIER
05 51 00.14 STEEL ANGLE 5 x 5 x 3/8 - WELD TO STEEL STRINGER
05 51 00.15 STEEL ANGLE 2 X 2 X 3/8
05 51 00.16 STEEL PLATE - 1/2 INCH
05 51 00.17 STEEL PLATE - 1/4 INCH

05 51 00.20 STEEL PIPE GUARDRAIL - 1-1/2 INCH O.D.
05 51 00.21 STEEL PIPE GUARDRAIL POST - 1-1/2 INCH O.D.
05 51 00.22 STEEL PIPE HANDRAIL - 1-1/2 INCH O.D.
05 51 00.24 STEEL HANDRAIL BRACKET
05 51 00.25 STEEL HANDRAIL POST BRACKET
05 51 00.26 STEEL POST CANOPY
05 51 00.27 STEEL TUBE HANDRAIL - SIZE AS NOTED OR DRAWN
05 51 00.28 STEEL LOGO - 1/2 INCH THICK - SEE SIGNAGE DRAWINGS
05 51 00.29 STEEL TUBE HANDRAIL POST - SIZE AS NOTED OR DRAWN

05 51 00.32 STAINLESS STEEL INTERMEDIATE HANDRAIL WITH POSTS ANCHORED TO FLOOR
05 51 00.33 STAINLESS STEEL PIPE HANDRAIL - 1-1/2 INCH O.D.
05 51 00.34 STAINLESS STEEL HANDRAIL BRACKET
05 51 00.35 STAINLESS STEEL HANDRAIL POST BRACKET
05 51 00.36 STAINLESS STEEL BAR - 3/4 INCH X 2 INCH
05 51 00.37 STAINLESS STEEL BAR - 1/2 INCH X 1 1/2 INCH
05 51 00.38 STAINLESS STEEL POST CANOPY
05 51 00.39 STEEL BAR - 1/2 INCH x 1-1/2 INCH
05 51 00.40 STEEL BAR - 3/8 INCH x 3/8 INCH
05 51 00.41 STEEL BAR - 1/2 INCH x 1/2 INCH

05 51 00.44 STEEL BAR - 1 1/2 INCH X 4 INCH
05 51 00.45 STEEL BAR - 5/8 INCH x 5/8 INCH
05 51 00.46 STEEL BAR - 5/8 INCH DIA.
05 51 00.47 STEEL BAR - 5/8 INCH x 1 INCH
05 51 00.48 STEEL BAR - 1 INCH x 1 INCH
05 51 00.49 STEEL BAR - 1 INCH x 1-1/2 INCH
05 51 00.50 STEEL BAR - 1 1/2 INCH X 1 1/2 INCH

05 51 00.51 STEEL ANGLE LINTEL - REFERENCE STRUCTURAL STEEL SCHEDULE

05 51 00.60 WELD TO STEEL FRAMING
05 51 00.62 STEEL TRIANGLE SUPPORT BRACKET - 2 INCH WIDE x 1/4 INCH THICK @ 18 INCHES O.C. MAX
PREDRILLED INSTALLATION @ FASTENING HOLES

05 51 00.70 STEEL PIPE - 1.900 O.D.

05 51 00.81 STAINLESS STEEL INFILL PANEL - TYPE 1
05 51 00.82 STAINLESS STEEL INFILL PANEL - TYPE 2
05 51 00.83 STAINLESS STEEL U-EDGING - WELDED MITERED CORNERS - MILL FINISH
05 51 00.84 STEEL GLASS BRACKET CLAMP - SPIDER TYPE - SINGLE
05 51 00.85 STEEL GLASS BRACKET CLAMP - SPIDER TYPE - DOUBLE
05 51 00.86 STAINLESS STEEL GLASS CLAMP - SATIN FINISH - SIZE AS DRAWN OR NOTED

05 51 00.93 STEEL PIPE RAIL POST - EXTERIOR
05 51 00.94 STEEL HANDRAIL BRACKET - EXTERIOR
05 51 00.95 STEEL BAR BALUSTER - 5/8 INCH DIA.- EXTERIOR
05 51 00.96 STEEL PIPE RAIL - 1-1/2 INCH O.D.- EXTERIOR
05 51 00.97 STEEL PIPE GUARDRAIL - 1-1/2 INCH NOM. DIA. - EXTERIOR
05 51 00.98 STEEL PIPE SLEEVE
05 51 00.99 CORE DRILL 4 INCH x 12 INCH DEEP POST PLACEMENT - GROUT SOLID TYPICAL

05 58 13 COLUMN COVERS

05 58 13.01 METAL COLUMN COVERS

DIVISION 06 - WOOD PLASTICS AND COMPOSITES

06 10 00 ROUGH CARPENTRY

06 10 00.01 WOOD BLOCKING - (2X) CONTINUOUS - PRESSURE TREATED - ROOF EDGE - SIZE AS NOTED OR DRAWN -
STAGGER BOLTED TO ANGLE AT 32 INCHES O.C.
06 10 00.02 WOOD BLOCKING - (2X) CONTINUOUS WITH PLYWOOD SHIMS - PRESSURE TREATED - ROOF EDGE - SIZE AS NOTEI
STAGGER BOLTED TO ANGLE AT 32 INCHES O.C.

06 10 00.04 WOOD BLOCKING - (2X) CONTINUOUS - PRESSURE TREATED - SIZE AS REQUIRED -
ESTABLISH LEVEL INSTALLATION SURFACE FOR ROOFTOP CURB
06 10 00.05 WOOD BLOCKING - (2X) CONTINUOUS - PRESSURE TREATED - LOCKER BASE - SIZE AS NOTED OR DRAWN - BOLT II

06 10 00.11 WOOD BLOCKING - 2X PRESSURE TREATED - SIZE AS NOTED OR DRAWN
06 10 00.12 WOOD BLOCKING - 1X PRESSURE TREATED - SIZE AS NOTED OR DRAWN

06 10 00.21 WOOD BLOCKING - 2X FIRE RETARDANT TREATED - SIZE AS NOTED OR DRAWN
06 10 00.23 WOOD BLOCKING - FIRE RETARDANT TREATED - SIZE AS NOTED OR DRAWN

06 10 00.31 PLYWOOD - 1/4 INCH
06 10 00.32 PLYWOOD - 1/2 INCH

06 10 00.33 PLYWOOD - 5/8 INCH
06 10 00.34 PLYWOOD - 3/4 INCH
06 10 00.35 PLYWOOD - 3/4 INCH CONTINUOUS BETWEEN METAL STUDS - COORDINATE PLACEMENT WITH PROJECTOR SUPPC
06 10 00.36 PLYWOOD - 3/8 INCH

06 10 00.41 PLYWOOD PRESSURE TREATED - 1/4 INCH
06 10 00.42 PLYWOOD PRESSURE TREATED - 1/2 INCH
06 10 00.43 PLYWOOD PRESSURE TREATED - 5/8 INCH
06 10 00.44 PLYWOOD PRESSURE TREATED - 3/4 INCH

06 10 00.51 WOOD STUD - 2X4 - 16 INCHES O.C. - SHOP WORKSTATION
06 10 00.52 WOOD STUD - 2X6 - 16 INCHES O.C. - SHOP WORKSTATION
06 10 00.53 WOOD TOP PLATE - (2) 2X4 CONTINUOUS - SHOP WORKSTATION
06 10 00.54 WOOD TOP PLATE - (2) 2X6 CONTINUOUS - SHOP WORKSTATION
06 10 00.55 WOOD SOLE PLATE - 2X4 CONTINUOUS - SHOP WORKSTATION
06 10 00.56 WOOD SOLE PLATE - 2X6 CONTINUOUS - PRESSURE TREATED - SHOP WORKSTATION
06 10 00.57 WOOD BOARD - 1X12 - SHOP WORKSTATION
06 10 00.58 WOOD CEILING JOIST - 2X12 - 16 INCHES O.C. - SHOP WORKSTATION

06 10 00.80 2X WOOD STRINGER - FIRE TREATED
06 10 00.82 2X4 PRESSURE TREATED SLEEPERS - 16 INCHES O.C.

06 10 00.90 EXPANSION BOLT
06 10 00.92 INSECT SCREEN

06 16 00 GYPSUM SHEATHING

06 16 00.01 GYPSUM EXTERIOR SHEATHING - 1/2 INCH

06 20 00 FINISH CARPENTRY

06 20 00.01 HARDWOOD MILLWORK - TRANSPARENT FINISH
06 20 00.02 HARDWOOD TRIM - TRANSPARENT FINISH
06 20 00.03 HARDWOOD TRIM - 3/4 INCH - PENCILED EDGE 1/8 INCH RADIUS - TRANSPARENT FINISH
06 20 00.04 HARDWOOD SILL - 3/4 INCH - 1/4 INCH RADIUS EASED EDGE - TRANSPARENT FINISH

06 20 00.10 PVC PANEL - 1/2 INCH THICK
06 20 00.11 PVC PANEL - 5/8 INCH THICK
06 20 00.12 PVC TRIM - 5/4x4
06 20 00.13 PVC TRIM - 5/4x6
06 20 00.14 PVC TRIM - 5/4x8
06 20 00.15 PVC TRIM - 5/4x10
06 20 00.16 PVC TRIM - SIZE AS NOTED
06 20 00.17 PVC TRIM - 1x4
06 20 00.18 PVC TRIM - 1x6
06 20 00.19 PVC TRIM - 1x8
06 20 00.20 PVC TRIM - 1x10

06 20 00.21 HARDWOOD TRIM - 1/2 INCH - TRANSPARENT FINISH
06 20 00.23 HARDWOOD TRIM - 3/4 INCH - TRANSPARENT FINISH
06 20 00.24 HARDWOOD TRIM - 1 INCH - TRANSPARENT FINISH
06 20 00.25 HARDWOOD SHELF 1 INCH - TRANSPARENT FINISH
06 20 00.26 HARDWOOD TRIM - 5/4 INCH - TRANSPARENT FINISH

06 20 00.29 HARDWOOD BULLNOSE - TRANSPARENT FINISH

06 20 00.31 HARDWOOD VENEER PLYWOOD - 1/2 INCH - TRANSPARENT FINISH
06 20 00.32 HARDWOOD VENEER PLYWOOD - 5/8 INCH - TRANSPARENT FINISH
06 20 00.33 HARDWOOD VENEER PLYWOOD - 3/4 INCH - TRANSPARENT FINISH
06 20 00.34 HARDWOOD EDGING ON PLYWOOD - TRANSPARENT FINISH

06 20 00.35 PANEL FIXING - TOP-BOTTOM MOUNT - DOUBLE SIDED
06 20 00.36 PANEL FIXING - TOP-BOTTOM MOUNT - SINGLE SIDED
06 20 00.37 CABLE FIXING - TOP-BOTTOM ASSEMBLY CHANNEL
06 20 00.38 CABLE FIXING - FLOOR TO CEILING MOUNT
06 20 00.39 CABLE FIXING - WALL TO WALL MOUNT
06 20 00.40 CABLE - 1/8 INCH THICK WITH TENSIONER
06 20 00.41 CABLE DISPLAY SYSTEM - SATIN FINISH

06 20 00.42 PLYWOOD - 1/2 INCH
06 20 00.43 PLYWOOD - 3/8 INCH - 2 LAYERS
06 20 00.44 PLYWOOD - 3/4 INCH
06 20 00.45 FIXED SURFACE MOUNT CABLE TERMINATION - STAINLESS STEEL
06 20 00.46 SURFACE MOUNT SWIVEL TURNBUCKLE - STAINLESS STEEL
06 20 00.47 1 x 3 INCH PRESSURE TREATED PLYWOOD BLOCKING
06 20 00.48 1 x 4 INCH PRESSURE TREATED PLYWOOD BLOCKING
06 20 00.49 FASTENER
06 20 00.50 MDF PLYWOOD - SCULPTED DECORATIVE PANEL
06 20 00.51 MDF PLYWOOD - 1/2 INCH
06 20 00.53 MDF PLYWOOD - 3/4 INCH

06 20 00.55 MDO PLYWOOD - 3/4 INCH
06 20 00.56 PEGBOARD - 1/4 INCH THICK
06 20 00.57 STAINLESS STEEL EYE HOOK
06 20 00.58 ALUMINUM REVEAL CHANNEL - 1/2 INCH X 1/2 INCH
06 20 00.59 DROP BOX
06 20 00.60 FLAG HOOK STANDOFF WITH CAP
06 20 00.61 VENTED WALL BASE
06 20 00.62 HARDBOARD STAGE FLOORING

06 20 00.63 FLATHEAD STAINLESS STEEL WOOD SCREW – COUNTERSUNK
06 20 00.64 WALL SAFE
06 20 00.65 ALUMINUM REVEAL CHANNEL - 1 INCH
06 20 00.66 CLEAT HANGER
06 20 00.67 CORRUGATED METAL PANEL
06 20 00.68 CORRUGATED METAL TRIM - J PROFILE - 2 INCH FACE - 1-1/4 INCH DEPTH - FINISH TO MATCH ADJACENT PANEL
06 20 00.69 ALUMINUM H MOLDING - 3/8 INCH EXPOSED FACE
06 20 00.70 ALUMINUM OUTSIDE CORNER TRIM - 3/8 INCH EXPOSED FACE
06 20 00.71 STAINLESS STEEL SCREWS - COUNTERSUNK
06 20 00.72 STAINLESS STEEL SCREWS - WITH FINISH WASHERS
06 20 00.73 STAINLESS STEEL BOLTS - NUTS AND WASHERS - 1/2 INCH DIA
06 20 00.74 STAINLESS STEEL WIRE ROPE - 3/8 INCH DIAMETER
06 20 00.75 STAINLESS STEEL SWAGE WALL MOUNT WITH FASTENERS
06 20 00.76 STAINLESS STEEL TURNBUCKLE
06 20 00.77 LOCK
06 20 00.78 HINGE
06 20 00.79 RECYCLING BIN - PROVIDED BY FFE
06 20 00.80 STEEL UNDER COUNTER SUPPORT BRACKET - SIZE AS NOTED OR DRAWN
06 20 00.81 PLASTIC LAMINATE COUNTER TOP
06 20 00.82 PLASTIC LAMINATE BACKSPLASH - 4 INCH
06 20 00.83 PLASTIC LAMINATE
06 20 00.84 GROMMET - 3 INCH - PLASTIC
06 20 00.85 SHELVING BRACKET
06 20 00.86 WIRE MANAGEMENT HOOKS - 12 INCHES O.C. - UNDER COUNTER
06 20 00.87 SLIDING KEYBOARD / MOUSE TRAY
06 20 00.88 ESCUTCHEON PLATE
06 20 00.89 1-1/2 INCH BRUSHED STAINLESS STEEL POST

06 20 00.90 HARDWOOD TREAD AND RISER TO MATCH STAGE FLOOR - TRANSPARENT FINISH
06 20 00.91 HARDWOOD HANDRAIL - TRANSPARENT FINISH
06 20 00.92 STAINLESS STEEL CABLE - 1/4 INCH DIAMETER
06 20 00.93 ISOLATION BUSHING - DIAMETER AS REQUIRED FOR CABLE SIZE
06 20 00.94 BUTTON STUD TENSIONER
06 20 00.95 STAINLESS STEEL BAR RAIL
06 20 00.96 STAINLESS STEEL PIPE - 1-1/2 INCH DIAMETER - POLISHED FINISH
06 20 00.97 FIXED MOUNT PIPE SUPPORT
06 20 00.98 WOOD BLOCKING - FIRE RETARDANT TREATED - SIZE AS REQUIRED
06 20 00.99 WOOD BLOCKING - SIZE AS REQUIRED

06 40 00 ARCHITECTURAL WOODWORK

06 40 00.01 ADMINISTRATION CIRCULATION DESK
06 40 00.02 MAILBOX UNITS
06 40 00.03 LIBRARY CIRCULATION DESK
06 40 00.04 LIBRARY COMPUTER DESK
06 40 00.05 DISPLAY CASE
06 40 00.06 FABRIC FACED TACK BOARD

06 40 00.13 METAL LAMINATE
06 40 00.14 PLASTIC LAMINATE
06 40 00.15 TACKABLE SURFACE - TYPE 1
06 40 00.16 TACKABLE SURFACE - TYPE 2

06 40 00.21 HARDWOOD TRIM - 1/2 INCH - TRANSPARENT FINISH
06 40 00.22 HARDWOOD TRIM - 3/4 INCH - TRANSPARENT FINISH
06 40 00.23 HARDWOOD TRIM - 1 INCH - TRANSPARENT FINISH

06 40 00.25 HARDWOOD TRIM - 3/4 INCH - PENCILED EDGE 1/8 INCH RADIUS - TRANSPARENT FINISH

06 40 00.31 HARDWOOD VENEER PLYWOOD - 1/2 INCH - TRANSPARENT FINISH
06 40 00.32 HARDWOOD VENEER PLYWOOD - 3/4 INCH - TRANSPARENT FINISH
06 40 00.33 HARDWOOD VENEER PLYWOOD - 1 INCH - TRANSPARENT FINISH

06 40 00.35 HARDWOOD EDGING ON PLYWOOD - TRANSPARENT FINISH

06 40 00.41 PLYWOOD - 1/2 INCH
06 40 00.42 PLYWOOD - 3/4 INCH

06 40 00.52 HARDWOOD EDGE TRIM - TRANSPARENT FINISH

06 40 00.61 WOOD BLOCKING - 2X
06 40 00.62 WOOD BLOCKING - SIZE AS REQUIRED

06 40 00.66 SLAT BRACKET SUPPORT - SILVER FROST FINISH
06 40 00.67 BAR BRACKET - GLASS SHELF SUPPORT - SILVER FROST FINISH
06 40 00.68 HEAVY DUTY BRACKET - GLASS SHELF SUPPORT - SILVER FROST FINISH
06 40 00.69 GLASS SHELF - 3/8 INCH THICK - CLEAR TEMPERED

06 40 00.71 LOCK
06 40 00.72 CABINET DOOR
06 40 00.73 DOUBLE ACTION SPRING HINGE
06 40 00.74 HINGE
06 40 00.75 STAINLESS STEEL INFILL PANEL - TYPE 1
06 40 00.76 DROP-IN DEAL TRAY
06 40 00.77 METAL GLAZING CHANNEL
06 40 00.78 WIRE PULL
06 40 00.79 CARD HOLDER - 1 INCH X 3 INCH - FAUX IRON FINISH WITH MATCHING FASTENERS

06 40 00.81 WOOD FRAMED SLIDING GLASS DOORS - SET IN ALUMINUM TRACKS - PROVIDE LOCKS

06 40 00.82 ADJUSTABLE SHELVING STANDARDS AND BRACKETS
06 40 00.83 FIXED GLASS PANEL
06 40 00.84 GLASS SHELVING AND BRACKETS
06 40 00.85 GLASS DOOR
06 40 00.86 GLASS DOOR HARDWARE
06 40 00.87 ALUMINUM FRAME CABINET DOOR - SATIN FINISH

06 40 00.91 ALUMINUM H MOLDING - 3/8 INCH EXPOSED FACE
06 40 00.92 ALUMINUM OUTSIDE CORNER TRIM - 3/8 INCH EXPOSED FACE
06 40 00.93 SLIDING KEYBOARD / MOUSE TRAY
06 40 00.94 ESCUTCHEON PLATE
06 40 00.95 1-1/2 INCH BRUSHED STAINLESS STEEL POST
06 40 00.96 ACCESS PANEL
06 40 00.97 3 INCH GROMMET - PLASTIC
06 40 00.98 WIRE MANAGEMENT HOOKS - 12 INCHES O.C. - UNDER COUNTER
06 40 00.99 UNDER COUNTER STEEL SUPPORT WITH PRE-DRILLED HOLES

06 55 00 SOLID SURFACING

06 55 00.01 SOLID SURFACE MATERIAL
06 55 00.02 SEALANT
06 55 00.03 PLYWOOD BACKING
06 55 00.04 ADHESIVE
06 55 00.05 Z-CLIPS SECURED TO BLOCKING AND SOLID SURFACING
06 55 00.06 GROMMET
06 55 00.10 COUNTER LIFT AND HOLD HARDWARE

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

07 16 13 POLYMER MODIFIED CEMENT WATERPROOFING

07 16 13.01 POLYMER MODIFIED CEMENT WATERPROOFING MATERIAL

07 21 00 THERMAL INSULATION

07 21 00.01 RIGID INSULATION - 2 INCH - FOUNDATION ONLY
07 21 00.02 RIGID INSULATION - 2 INCH - UNDER SLAB - HIGH COMPRESSIVE STRENGTH

07 21 00.11 RIGID INSULATION - 3 INCH - EXTERIOR WALL

07 21 00.20 GLASS FIBER INSULATION
07 21 00.21 GLASS FIBER ACOUSTICAL BLANKET INSULATION - 6 INCH - UNFACED
07 21 00.22 GLASS FIBER ACOUSTICAL BLANKET INSULATION - 3 1/2 INCH - UNFACED

07 21 00.30 MINERAL FIBER INSULATION
07 21 00.31 MINERAL FIBER ACOUSTICAL INSULATION - 6 INCH
07 21 00.32 MINERAL FIBER ACOUSTICAL INSULATION - 3 1/2 INCH

07 21 00.40 FOAMED IN PLACE INSULATION / AIR BARRIER

07 21 00.50 BACKER ROD AND SEALANT - TYPE AS REQUIRED

07 24 20 EXTERIOR FINISH SYSTEM (EFS)

07 24 20.01 EXTERIOR FINISH - TYPE AND COLOR SELECTED BY ARCHITECT
07 24 20.11 1/2 INCH EXTERIOR GRADE SHEATHING
07 24 20.12 CONTROL JOINT
07 24 20.13 BACKER ROD AND SEALANT - TYPE AS REQUIRED
07 24 20.14 ALUMINUM SOFFIT VENT

07 26 00 VAPOR RETARDERS

07 26 00.01 VAPOR RETARDER - UNDER SLAB
07 26 00.02 FOAMED-IN-PLACE INSULATION WITH BACK ROD AS REQUIRED
07 26 00.03 VAPOR RETARDER - UNDER STAGE FLOORING
07 26 00.04 VAPOR RETARDER - TAPE SEAMS

07 27 13 MODIFIED SHEET AIR BARRIER

07 27 13.01 AIR/VAPOR BARRIER MEMBRANE - SELF-ADHERING
07 27 13.02 AIR/VAPOR BARRIER TRANSITION MEMBRANE - SELF-ADHERING

07 27 13.10 WATERPROOF MEMBRANE FLASHING

07 27 13.20 COPPER FABRIC FLASHING
07 27 13.21 FASTENER
07 27 13.22 END DAM

07 27 13.30 ALUMINUM FLASHING
07 27 13.31 ALUMINUM FLASHING CLEAT

07 27 19 WATER RESISTANT MEMBRANE

07 27 19.01 WATER RESISTANT MEMBRANE - DRAINAGE FABRIC

07 42 43 COMPOSITE PANELS

07 42 43.01 COMPOSITE ALUMINUM METAL PANELS

07 42 43.02	ALUMINUM TRACK SYSTEM
07 42 43.03	PLASTIC SHIMS
07 42 43.04	FASTENERS
07 42 43.05	SEALANT
07 42 43.06	SUPPORT SYSTEM
07 42 43.07	ALUMINUM BREAK METAL FLASHING - COLOR TO MATCH METAL PANEL
07 46 46	**MINERAL FIBER CEMENT SIDING**
07 46 46.01	MINERAL FIBER CEMENT SIDING
07 46 46.05	MINERAL FIBER CEMENT BOARD
07 46 46.11	WALL PANEL - FIBER-REINFORCED CEMENT
07 46 46.12	FASTENER
07 46 46.21	BUG SCREEN - CONTINUOUS
07 46 46.31	J-CHANNEL TRIM
07 46 46.32	INSIDE CORNER TRIM
07 46 46.33	OUTSIDE CORNER TRIM
07 46 46.34	VERTICAL MOLDING TRIM
07 46 46.35	HORIZONTAL TRIM
07 46 46.36	BASE TRIM
07 46 46.37	DRIP CAP
07 46 46.38	PREFINISHED ALUMINUM FLASHING
07 46 46.41	1 x 3 INCH PRESSURE TREATED PLYWOOD BLOCKING
07 46 46.42	1 x 4 INCH PRESSURE TREATED PLYWOOD BLOCKING
07 53 23	**ETHYLENE PROPYLENE DIENE MONOMER (EPDM) ROOFING**
07 53 23.01	EPDM SINGLE PLY MEMBRANE ROOFING
07 53 23.02	HIGH DENSITY POLY-ISO RECOVERY BOARD
07 53 23.03	RIGID INSULATION - 6 INCH EXTRUDED
07 53 23.04	RIGID INSULATION - TAPERED
07 53 23.05	COATED METAL FLASHING
07 53 23.06	FLASHING MEMBRANE
07 53 23.09	SHEET VAPOR RETARDER - TAPE SEAMS
07 53 23.10	CANT STRIPS
07 53 23.11	FLAT SECUREMENT BARS
07 53 23.20	WALKWAY PADS
07 53 23.30	SEALANT - CONTINUOUS
07 53 23.31	ADHESIVE
07 53 23.40	EPDM EXPANSION JOINT
07 53 23.41	FOAM ROD TUBING - CONTINUOUS
07 62 00	**SHEET METAL FLASHING AND TRIM**
07 62 00.01	SHEET METAL FLASHING
07 62 00.02	SHEET METAL COUNTER FLASHING
07 62 00.03	SPRING LOCK FLASHING
07 62 00.04	FLASHING REGLET
07 62 00.10	METAL COPING
07 62 00.20	SEALANT - TYPE AS REQUIRED
07 71 00	**ROOF SPECIALTIES**
07 71 00.01	FACTORY FABRICATED FASCIA TRIM/ROOF EDGE - CUSTOM COLOR
07 71 00.02	EXPOSED ALUMINUM FINISH METAL - CUSTOM COLOR
07 71 00.03	ALUMINUM DRIP EDGE - CUSTOM COLOR
07 71 00.10	SOFFIT STRIP VENT
07 71 00.20	CONTINUOUS SEALANT - TYPE AS REQUIRED
07 72 00	**ROOF ACCESSORIES**
07 72 00.01	ROOF SCUTTLE - TYPE 1 - 3'-0" x 3'-0"
07 72 00.02	ROOF SCUTTLE - TYPE 2 - 3'-0" x 5'-0"
07 72 00.10	NEOPRENE GASKET ENTIRE PERIMETER TYP.
07 72 00.11	RIGID INSULATION
07 72 00.12	SPRING LATCH W/ HANDLE AND PADLOCK HASP ON INSIDE
07 72 00.13	PADLOCK HASP
07 72 00.20	ELEVATOR ROOFTOP LOUVER
07 72 00.30	12 GA. ALUM. ROOF W/ INSULATION
07 72 00.31	STORM PROOF LOUVER BLADE (THREE SIDES)
07 72 00.32	INSECT SCREEN
07 72 00.33	GLASS WINDOW
07 72 00.34	RUBBER GASKET
07 72 00.35	RIGID INSULATION

07 72 00.40 WELDED ALUMINUM CURB

07 72 00.50 ROOF GUARDRAIL SYSTEM

07 72 00.60 HEAT AND SMOKE VENT - 5'-6" x 12'-0"

07 81 00 APPLIED FIREPROOFING

07 81 00.01 CEMENTITIOUS FIREPROOFING

07 84 00 FIRE STOPPING

07 84 00.01 FIRE SAFING MINERAL WOOL
07 84 00.02 CAULK - CAULK AND PUTTY
07 84 00.03 FIRE STOP MORTAR
07 84 00.04 FIRE STOP PILLOWS

07 92 00 JOINT SEALERS

07 92 00.01 JOINT SEALANT - TYPE AS REQUIRED
07 92 00.02 BACKER ROD AND SEALANT - TYPE AS REQUIRED
07 92 00.03 BACKER ROD - TYPE AS REQUIRED
07 92 00.11 EXTERIOR EXPANSION JOINT - 2 INCH

07 95 13 CONSTRUCTION AND EXPANSION JOINTS

07 95 13.01 EXPANSION JOINT COVER - 2 INCH - INTERIOR - FLOOR / FLOOR
07 95 13.02 EXPANSION JOINT COVER - 2 INCH - INTERIOR - WALL / WALL - MASONRY
07 95 13.03 EXPANSION JOINT COVER - 2 INCH - INTERIOR - WALL / WALL OR CEILING / CEILING - GYPSUM BASE
07 95 13.04 EXPANSION JOINT COVER - 2 INCH - INTERIOR - WALL / WALL CORNER - GYPSUM BASE
07 95 13.05 EXPANSION JOINT COVER - 2 INCH - INTERIOR - FLOOR / WALL
07 95 13.06 EXPANSION JOINT COVER - 2 INCH - INTERIOR - WALL/WALL - GYPSUM BASE
07 95 13.07 EXPANSION JOINT COVER - 2 INCH - INTERIOR - ACT/WALL

DIVISION 08 - DOORS AND HARDWARE

08 11 13 HOLLOW METAL DOORS AND FRAMES

08 11 13.01 DOOR AND FRAME- SEE DOOR SCHEDULE
08 11 13.10 STEEL DOOR - SEE SCHEDULE FOR TYPES
08 11 13.11 STEEL FRAME - SEE SCHEDULE FOR TYPES
08 11 13.20 STEEL FRAME CLIP BY FRAME INSTALLER
08 11 13.21 STEEL FRAME ANCHOR
08 11 13.22 PREFINISHED ALUMINUM FLASHING
08 11 13.30 3/4x3/4 GLAZING STOP

08 14 16 FLUSH WOOD DOORS

08 14 16.01 SOLID CORE FLUSH WOOD DOOR- SEE DOOR SCHEDULE
08 14 16.10 DUTCH DOOR WITH COUNTER

08 31 00 ACCESS DOORS AND PANELS

08 31 00.01 FIRE RATED ACCESS DOOR

08 31 00.11 ACCESS PANEL
08 31 00.12 ACCESS PANEL - FIRE RATED

08 33 13 COILING COUNTER DOORS

08 33 13.01 COILING COUNTER DOOR - TYPE CCD1 - INTERIOR - 8'-0"W x 4'-4"H - MANUALLY OPERATED
08 33 13.02 COILING COUNTER DOOR - TYPE CCD2 - EXTERIOR - 10'-8"W x 6'-0"H - MANUALLY OPERATED

08 33 13.21 VERTICAL GUIDES
08 33 13.31 COILING DOOR HOUSING

08 33 23 OVERHEAD COILING DOORS

08 33 23.01 TYPE OHC1 - 10'-0"W x 10'-4"H - EXTERIOR - INSULATED OVERHEAD COILING DOOR - ALUMINUM SLATS - ELECTRICA
08 33 23.02 TYPE OHC2 - 8'-0"W x 10'-0"H - EXTERIOR - INSULATED OVERHEAD COILING DOOR - ALUMINUM SLATS - ELECTRICAL
08 33 23.03 TYPE OHC3 - 10'-0"W x 8'-0"H - EXTERIOR - INSULATED OVERHEAD COILING DOOR - ALUMINUM SLATS - ELECTRICAL
08 33 23.04 TYPE OHC4 - 12'-0"W x 12'-0"H - EXTERIOR - INSULATED OVERHEAD COILING DOOR - ALUMINUM SLATS - ELECTRICA
08 33 23.05 TYPE OHC5 - 12'-0"W x 12'-0"H - EXTERIOR - INSULATED OVERHEAD COILING DOOR - ALUMINUM SLATS - ELECTRICA

08 33 23.11 VERTICAL GUIDES - GALVANIZED
08 33 23.12 ELECTRICAL MOTOR

08 33 26 OVERHEAD COILING GRILLES

08 33 26.01 OVERHEAD COILING GRILLE - TYPE OHG1 - 9'-6-1/2"W x 8'-0"H
08 33 26.02 OVERHEAD COILING GRILLE - TYPE OHG2 - 15'-0"W x 8'-6"H
08 33 26.03 OVERHEAD COILING GRILLE - TYPE OHG3 - 16'-10-3/4"W x 8'-6"H

08 33 26.11 ELECTRIC MOTOR
08 33 26.12 GUIDE

08 34 73 SOUND CONTROL DOORS

08 34 73.01	ACOUSTIC FLUSH WOOD DOOR - SEE DOOR SCHEDULE
08 35 13	**PANEL FOLDING DOORS**
08 35 13.01	PANEL FOLDING DOOR SYSTEM
08 35 15	**SLIDING GLASS PANEL**
08 35 15.01	SLIDING GLASS PANEL SYSTEM
08 35 15.11	GLASS PANEL - 3/8 INCH - LAMINATED TEMPERED WITH POLISHED EDGES
08 35 15.21	SINGLE POINT FIXING
08 35 15.22	SINGLE POINT FIXING WITH BOTTOM STRAP
08 35 15.23	SOCKET BOLT LOCK
08 35 15.24	SOCKET - PLUMB SET
08 35 15.31	TRACK RAIL
08 35 15.32	TRACK ROLLER
08 35 15.33	TRACK SUBSTRUCTURE
08 35 15.34	THREADED ROD
08 35 15.41	KICKER BRACE FIXING PLACE
08 35 15.42	KICKER BRACE STRUCTURE
08 35 15.43	KICKER BRACE FIXING ANGLE
08 35 17	**SIDE FOLDING GRILLES**
08 35 17.01	SIDE FOLDING GRILLE SYSTEM
08 35 17.11	SIDE FOLDING GRILLE - TYPE SFG1 - 16'-2"W x 11'-8"H
08 35 17.12	SIDE FOLDING GRILLE - TYPE SFG2 - 7'-6"W x 11'-4"H
08 35 17.13	SIDE FOLDING GRILLE - TYPE SFG3 - 16'-0"W x 11'-4"H
08 36 13	**MULTI-LEAF VERTICAL LIFT DOORS**
08 36 13.01	MULTI-LEAF VERTICAL DOOR - TYPE OH1 - EXTERIOR - 11'-4"W x 10'-8"H
08 36 13.02	MULTI-LEAF VERTICAL DOOR - TYPE OH2 - EXTERIOR - 11'-4"W x 10'-8"H
08 36 13.11	DOOR FRAME
08 36 13.12	GLAZING
08 36 13.13	TRACK
08 36 13.14	ROLLER ASSEMBLY
08 36 13.15	COUNTERWEIGHT COVER
08 42 26	**ALL-GLASS ENTRANCES**
08 42 26.01	ALL-GLASS ENTRANCE SYSTEM
08 42 26.11	GLASS DOOR
08 42 26.12	PIVOT HINGE
08 43 13	**ALUMINUM FRAMED STOREFRONTS**
08 43 13.01	ALUMINUM STOREFRONT FRAME
08 43 13.02	ALUMINUM STOREFRONT DOOR
08 43 13.03	PREFINISHED ALUMINUM FLASHING
08 43 13.04	BEAD OF SEALANT- CONTINUOUS- SET PREFINISHED ALUMINUM FLASHING IN SEALANT
08 43 13.05	AIR/VAPOR BARRIER TRANSITION MEMBRANE - SELF-ADHERING
08 43 13.06	CONTINUOUS SEALANT
08 43 13.20	SEALANT & BACKER ROD
08 43 13.21	CLEAR SILICONE BUTT JOINT - 3/8 INCH
08 43 13.29	SNAP TRIM - ALUMINUM - PROFILE TO MATCH GRAHAM WINDOWS PROFILE #6 SQUARE
08 43 13.30	SNAP TRIM - ALUMINUM - PROFILE TO MATCH DRAWINGS - 4 INCHES DEEP
08 43 13.31	SPANDREL GLASS
08 43 13.32	INSULATED PANEL
08 43 13.40	PREFINISHED ALUMINUM COLUMN COVER - CONCEALED FASTENERS - SIZE AS NOTED OR DRAWN
08 43 13.41	ALUMINUM BAR - ANNODIZED FINISH - 1/2 INCH X 1/2 INCH - MITRE CORNERS - SECURE WITH ADHESIVE
08 44 13	**GLAZED ALUMINUM CURTAIN WALL**
08 44 13.01	ALUMINUM CURTAIN WALL FRAME
08 44 13.02	SLOTTED BRACE CONNECTION - WELD TO TUBE STEEL
08 44 13.03	PREFINISHED ALUMINUM FLASHING
08 44 13.04	BEAD OF SEALANT- CONTINUOUS- SET PREFINISHED ALUMINUM FLASHING IN SEALANT
08 44 13.05	PERIMETER SEALANT
08 44 13.06	AIR/VAPOR BARRIER TRANSITION MEMBRANE - SELF-ADHERING
08 44 13.07	CONTINUOUS SEALANT
08 44 13.08	SUNSHADE SUPPORT CLIPS - FASTEN TO MULLION AS REQUIRED
08 44 13.09	FASTENER
08 44 13.11	SNAP COVER - TYPE 1
08 44 13.12	SNAP COVER - TYPE 2
08 44 13.13	SNAP COVER - TYPE 3
08 44 13.14	SNAP COVER - TYPE 4
08 44 13.15	SNAP TRIM - ALUMINUM - PROFILE TO MATCH DRAWINGS - 4 INCHES DEEP
08 44 13.16	SNAP TRIM - ALUMINUM - PROFILE TO MATCH GRAHAM WINDOWS PROFILE #6 SQUARE

08 44 13.20	SEALANT & BACKER ROD
08 44 13.21	SILICONE SHEET MEMBRANE - GLAZE INTO SYSTEM - CONTINUOUS BEAD OF SEALANT TO SEAL TO AVB
08 44 13.30	SPANDREL GLASS
08 44 13.31	INSULATED PANEL
08 44 26	**STRUCTURAL GLASS CURTAIN WALL**
08 44 26.01	STRUCTURAL GLASS CURTAIN WALL FRAME
08 44 26.02	SLOTTED BRACE CONNECTION - WELD TO TUBE STEEL
08 44 26.03	PREFINISHED ALUMINUM FLASHING
08 44 26.04	BEAD OF SEALANT- CONTINUOUS- SET PREFINISHED ALUMINUM FLASHING IN SEALANT
08 44 26.05	PERIMETER SEALANT
08 44 26.06	CONTINUOUS SEALANT
08 44 26.07	AIR/VAPOR BARRIER TRANSITION MEMBRANE - SELF-ADHERING
08 44 26.11	SNAP TRIM - ALUMINUM - PROFILE TO MATCH GRAHAM WINDOWS PROFILE #6 SQUARE
08 44 26.20	SEALANT & BACKER ROD
08 44 26.21	SILICONE SHEET MEMBRANE - GLAZE INTO SYSTEM - CONTINUOUS BEAD OF SEALANT TO SEAL TO AVB
08 44 26.30	SPANDREL GLASS
08 44 26.31	INSULATED PANEL
08 51 13	**ALUMINUM WINDOWS**
08 51 13.01	ALUMINUM WINDOW - SEE SCHEDULE
08 51 13.02	PERIMETER SEALANT
08 51 13.03	PREFINISHED ALUMINUM FLASHING
08 51 13.04	BEAD OF SEALANT - CONTINUOUS- SET PREFINISHED ALUMINUM FLASHING IN SEALANT
08 51 13.05	2x4 ALUMINUM STRUCTURAL TUBE
08 51 13.06	CONTINUOUS SEALANT
08 51 13.07	SPRAY FOAM INSULATION AND BACKER ROD - FILL VOID IN FRAME
08 51 13.08	AIR/VAPOR BARRIER TRANSITION MEMBRANE - SELF-ADHERING
08 51 13.09	ROUND PLASTIC WEEP HOLE
08 51 13.20	SPANDREL GLASS
08 51 13.30	SNAP TRIM - ALUMINUM - PROFILE TO MATCH DRAWINGS - 4 INCHES DEEP
08 51 13.31	SNAP TRIM - ALUMINUM - PROFILE TO MATCH GRAHAM WINDOWS PROFILE #17 STEPPED
08 51 13.32	ZERO MULL
08 51 13.33	STACK MULL
08 51 13.34	3 PIECE MULL
08 51 13.40	MINERAL FIBER INSULATION
08 56 19	**PASS WINDOWS**
08 56 19.01	PASS WINDOW
08 56 19.02	ALUMINUM FRAMED SLIDING GLASS DOORS - SET IN ALUMINUM TRACKS - PROVIDE LOCKS
08 56 19.03	SECURITY "H" BAR
08 56 19.04	SECURITY TRACK
08 71 00	**DOOR HARDWARE**
08 71 00.01	SEE DOOR SCHEDULE AND SPECIFICATION FOR HARDWARE
08 71 00.11	ALUMINUM THRESHOLD
08 80 00	**GLAZING**
08 80 00.01	GLASS TYPE 1
08 80 00.02	GLASS TYPE 2
08 80 00.03	GLASS TYPE 3
08 80 00.04	GLASS TYPE 4
08 80 00.05	GLASS TYPE 5
08 80 00.06	GLASS TYPE 6
08 80 00.10	SPEAK THROUGH - NO DRAFT - 5-1/4 INCH DIAMETER
08 80 00.21	SMOKE BAFFLE
08 80 00.22	SMOKE BAFFLE CHANNEL FRAMING - SATIN FINISH
08 80 00.31	ALUMINUM GLAZING CHANNEL - 1/2 INCH - SATIN FINISH
08 80 00.32	ALUMINUM STANDOFF GLAZING MOUNT - SATIN FINISH - 1 INCH DIAMETER - 2 INCH DEPTH
08 84 13	**DECORATIVE PLASTIC GLAZING**
08 84 13.01	DECORATIVE PLASTIC GLAZING - TYPE I
08 84 13.02	DECORATIVE PLASTIC GLAZING - TYPE II
08 84 13.03	DECORATIVE PLASTIC GLAZING - TYPE III
08 84 13.04	DECORATIVE PLASTIC GLAZING - TYPE IV
08 84 13.05	DECORATIVE PLASTIC GLAZING - TYPE V
08 84 13.06	DECORATIVE PLASTIC GLAZING - COUNTERTOP - TYPE VI
08 84 13.07	DECORATIVE PLASTIC GLAZING - TYPE VII
08 84 13.11	PLASTIC GLAZING CONNECTOR
08 84 13.12	PLASTIC GLAZING CABLE AND CABLE COUPLER
08 84 13.13	PLASTIC GLAZING TOP GRIPPER

08 84 13.14 PLASTIC GLAZING SURFACE BRACKET
08 84 13.15 PLASTIC GLAZING MOUNTING CHANNEL

08 84 13.21 STANDOFF PANEL MOUNT - SATIN FINISH - 1 INCH DIAMETER - 2 INCH DEPTH

08 90 00 LOUVERS AND VENTS

08 90 00.20 ALUMINUM LOUVER - SEE ELEVATIONS AND SPECIFICATION
08 90 00.21 BIRD SCREEN
08 90 00.22 BLANK OFF PANEL
08 90 00.23 PREFINISHED ALUMINUM FLASHING
08 90 00.31 SEALANT - TYPE AS REQUIRED

08 92 00 LOUVERED EQUIPMENT ENCLOSURES

08 92 00.01 LOUVERED EQUIPMENT ENCLOSURE
08 92 00.11 SCREEN BLADE
08 92 00.12 CLIP ANGLE
08 92 00.13 CONTINUOUS SUPPORT

DIVISION 09 - FINISHES

09 21 23 SHAFT WALL ASSEMBLIES

09 21 23.01 SHAFT ENCLOSURE - 2 HR RATING
09 21 23.04 HORIZONTAL SHAFT ENCLOSURE - 2 HR RATING
09 21 23.11 METAL SHAFTWALL C-H STUD - 2 1/2 INCH - 24 INCHES O.C. MAX
09 21 23.21 GYPSUM SHAFTWALL LINER PANEL - 1 INCH
09 21 23.31 GYPSUM BOARD - 5/8 INCH TYPE "X" - 1 LAYER
09 21 23.32 GYPSUM BOARD - 5/8 INCH TYPE "X" - 2 LAYERS

09 22 16 NON-STRUCTURAL METAL SUPPORT ASSEMBLIES

09 22 16.01 METAL STUD 1-5/8 INCH - 16 INCHES O.C. MAX
09 22 16.02 METAL STUD 2-1/2 INCH - 16 INCHES O.C. MAX
09 22 16.03 METAL STUD 3-5/8 INCH - 16 INCHES O.C. MAX
09 22 16.04 METAL STUD 4 INCH - 16 INCHES O.C. MAX
09 22 16.06 METAL STUD 6 INCH - 16 INCHES O.C. MAX
09 22 16.08 METAL STUD 8 INCH - 16 INCHES O.C. MAX
09 22 16.10 METAL STUD 10 INCH - 16 INCHES O.C. MAX

09 22 16.20 METAL STUD - REFER TO FLOOR PLANS FOR DEPTH
09 22 16.21 METAL FURRING CHANNEL - 7/8 INCH - 16 INCHES O.C. MAX

09 22 16.31 BOXED HEADER

09 22 16.41 METAL DEFLECTION TRACK ASSEMBLY
09 22 16.42 METAL DEFLECTION TRACK ASSEMBLY - FIRE RATED

09 22 16.51 METAL STUD BRACE
09 22 16.52 DOUBLE STUD JAMB - SIZE AS REQUIRED

09 22 16.91 STEEL PLATE - 20 GA. - SECURE TO EACH STUD
09 22 16.99 METAL CLIP FOR WALL FRAMING - 16 GA. - 24 INCHES O.C. MAX

09 29 00 GYPSUM BOARD

09 29 00.01 5/8 INCH GYPSUM BOARD - LEVEL 4 FINISH
09 29 00.02 5/8 INCH GYPSUM BOARD - 2 LAYERS - LEVEL 4 FINISH
09 29 00.09 5/8 INCH PLYWOOD

09 29 00.21 5/8 INCH GYPSUM BOARD - SAG-RESISTANT - LEVEL 4 FINISH

09 29 00.31 5/8 INCH GYPSUM BOARD - IMPACT RESISTANT - LEVEL 4 FINISH

09 29 00.41 CONTROL JOINT - 1/4 INCH
09 29 00.42 REVEAL - 1/2 INCH x 1/2 INCH
09 29 00.43 METAL MOLDING - CORNER BEAD
09 29 00.44 METAL MOLDING - "J" SHAPE

09 29 00.51 ALUMINUM REVEAL TRIM - 1 INCH
09 29 00.52 1 1/8 INCH SATIN FINISH ALUMINUM CORNER TRIM

09 29 00.99 GYPSUM BOARD SYSTEM - LEVEL 4 FINISH - REFER TO FLOOR PLANS AND WALL TYPES FOR COMPONENTS

09 30 13 CERAMIC TILING

09 30 13.01 CERAMIC MOSAIC FLOOR TILE
09 30 13.02 CERAMIC TILE BASE
09 30 13.11 GLAZED CERAMIC WALL TILE
09 30 13.12 GLAZED CERAMIC WALL TILE CAP
09 30 13.13 GLAZED CERAMIC WALL TILE COVE BASE

09 30 13.21 CERAMIC WALL TILE

09 30 13.31 MARBLE THRESHOLD
09 30 13.41 THIN SET TILE SETTING BED - ON GRADE
09 30 13.42 THIN SET TILE SETTING BED - ON DECK

09 30 13.43 THICK SET TILE SETTING BED
09 30 13.44 THIN SET TILE SETTING BED
09 30 13.51 CEMENTITIOUS BACKING BOARD

09 30 13.61 EDGE PROTECTION PROFILE - 1/2 INCH X 1/2 INCH SQUARE WITH ROUNDED CORNERS - STAINLESS STEEL

09 30 16 QUARRY TILING

09 30 16.01 QUARRY TILE
09 30 16.02 QUARRY TILE BASE
09 30 16.31 ALUMINUM TRANSITION STRIP
09 30 16.41 THICK SET TILE SETTING BED

09 30 19 PAVER TILING

09 30 19.01 PORCELAIN FLOOR TILE
09 30 19.02 PORCELAIN WALL TILE
09 30 19.11 PORCELAIN TILE BASE - 6" x 12"
09 30 19.21 PORCELAIN FLOOR TILE - 6" x 6"
09 30 19.22 PORCELAIN FLOOR TILE - 12" x 12"
09 30 19.23 PORCELAIN FLOOR TILE - 18" x 18"
09 30 19.31 PORCELAIN WALL TILE - 13" x 40"
09 30 19.32 PORCELAIN WALL TILE - 6" x 18"
09 30 19.41 THIN SET TILE SETTING BED
09 30 19.51 CEMENTITIOUS BACKING BOARD

09 51 00 ACOUSTICAL CEILINGS

09 51 00.01 ACT TYPE-1
09 51 00.02 ACT TYPE-2
09 51 00.03 ACT TYPE-3
09 51 00.04 ACT TYPE-4
09 51 00.05 ACT TYPE-5
09 51 00.06 ACT TYPE-6
09 51 00.07 ACT TYPE-7
09 51 00.08 ACT TYPE-8
09 51 00.09 ACT TYPE-9
09 51 00.10 ACT TYPE-10
09 51 00.11 ACT TYPE-11
09 51 00.12 ACT TYPE-12
09 51 00.13 ACT TYPE-13

09 51 00.21 PERIMETER EDGE TRIM SYSTEM
09 51 00.31 RETENTION CLIPS
09 51 00.41 ACT SUSPENSION SYSTEM

09 51 00.97 ACOUSTICAL CLOUD - REFERENCE REFLECTED CEILING PLANS FOR TYPE AND HEIGHT
09 51 00.98 WOOD VENEER CEILING SYSTEM - REFERENCE REFLECTED CEILING PLANS FOR TYPE AND HEIGHT
09 51 00.99 ACOUSTICAL CEILING - REFERENCE REFLECTED CEILING PLANS FOR TYPE AND HEIGHT

09 64 29 WOOD STRIP AND PLANK FLOORING

09 64 29.01 WOOD STRIP AND PLANK FLOOR
09 64 29.11 HARDWOOD TRIM - 1" x 8" WITH BULLNOSE
09 64 29.12 WOOD BLOCKING - SIZE AS REQUIRED
09 64 29.21 PLYWOOD UNDERLAYMENT - 5/8 INCH
09 64 29.22 SLEEPERS AND SHIMS
09 64 29.23 VAPOR RETARDER

09 64 66 WOOD ATHLETIC FLOORING

09 64 66.01 WOOD ATHLETIC FLOOR
09 64 66.02 RUBBER COVE WALL BASE - VENTED
09 64 66.05 GAME LINES - COURT MARKINGS - PAINTED
09 64 66.06 LOGO - PAINTED
09 64 66.07 STENCIL LETTERING - PAINTED

09 65 13 RESILIENT BASE AND ACCESSORIES

09 65 13.01 RUBBER BASE - 4"
09 65 13.02 RUBBER BASE - 2"

09 65 16 RESILIENT SHEET FLOORING

09 65 16.01 RESILIENT SHEET VINYL FLOORING
09 65 16.11 TRANSITION STRIP

09 65 19 RESILIENT TILE FLOORING

09 65 19.01 VINYL COMPOSITION TILE
09 65 19.11 VINYL REDUCER STRIP

09 65 23 RUBBER FLOORING

09 65 23.01 RUBBER FLOOR TILE - RAISED STUD PROFILE - STAIR TREADS/RISERS AND LANDINGS
09 65 23.02 RUBBER FLOOR TILE - HAMMERED PROFILE
09 65 23.03 RUBBER FLOOR TILE - ATHLETIC
09 65 23.11 RUBBER BASE

09 65 36	**STATIC-CONTROL RESILIENT FLOORING**
09 65 36.01	STATIC-CONTROL COMPOSITE TILE
09 67 33	**THIN-FILM EPOXY FLOORING SYSTEM**
09 67 33.01	THIN-FILM EPOXY FLOOR
09 67 66	**FLUID-APPLIED ATHLETIC FLOORING**
09 67 66.01	POURED-IN-PLACE ATHLETIC FLOORING SYSTEM
09 67 66.02	GAME LINES
09 67 66.11	ZINC EDGE STRIPS
09 68 00	**CARPETING**
09 68 00.01	CARPET
09 68 00.02	CARPET BORDER
09 68 00.11	RUBBER CARPET REDUCING STRIP
09 68 00.12	METAL CARPET REDUCING STRIP
09 68 00.13	VINYL STAIR NOSING
09 68 00.14	BOUND EDGING
09 68 00.15	RUBBER STAIR TREAD NOSING
09 72 00	**WALL COVERINGS**
09 72 00.01	VINYL WALL COVERING
09 84 00	**ACOUSTICAL ROOM COMPONENTS**
09 84 00.01	ACOUSTICAL PANEL - WALL MOUNTED - TYPE 1
09 84 00.02	ACOUSTICAL PANEL - WALL MOUNTED - TYPE 2
09 84 00.03	ACOUSTICAL PANEL - WALL MOUNTED - TYPE 3
09 84 00.04	ACOUSTICAL PANEL - WALL MOUNTED - TYPE 4
09 84 00.05	ACOUSTICAL PANEL - CEILING MOUNTED - TYPE 5
09 84 00.06	ACOUSTICAL PYRAMID PANEL - CEILING MOUNTED - TYPE 6
09 84 00.07	ACOUSTICAL PANEL - WALL MOUNTED - TYPE 7
09 84 00.08	ACOUSTICAL PANEL - WALL MOUNTED - TYPE 8
09 84 00.09	ACOUSTICAL PANEL - CEILING MOUNTED TYPE 9
09 84 00.10	ACOUSTICAL PANEL - WALL MOUNTED - TYPE 10
09 84 00.99	CONCEALED "Z" CLIP MOUNTING SYSTEM
09 91 00	**PAINTING**
09 91 00.01	PAINT - SEE SCHEDULE
09 96 00	**HIGH-PERFORMANCE COATINGS**
09 96 00.01	HIGH PERFORMANCE COATING

DIVISION 10 - SPECIALTIES

10 11 16	**MARKER BOARDS**
10 11 16.01	DRY MARKER BOARD
10 11 16.02	SLIDING DRY MARKER BOARD
10 11 16.11	TACK BOARD
10 11 16.12	2 INCH TACK BOARD STRIP
10 11 16.19	TACK BOARD WALL
10 11 16.21	PROJECTOR MARKER BOARD
10 11 16.31	SILK SCREEN - MUSIC STAFF LINING
10 11 16.32	SILK SCREEN - GRAPHIC COORDINATES LINING
10 12 00	**DISPLAY CASES**
10 12 00.01	DISPLAY CASE
10 14 00	**SIGNAGE**
10 14 00.01	INTERIOR SIGNAGE - TYPE AS SCHEDULED
10 14 00.02	INTERIOR SIGNAGE - METAL LETTERS
10 14 00.03	INTERIOR SIGNAGE - VINYL APPLIED GRAPHIC - TYPE AS SCHEDULED
10 14 00.10	STANDOFF HARDWARE
10 14 00.21	ALUMINUM EXTERIOR SIGN - TWO SIDED
10 14 00.22	EXTERIOR LED SIGN
10 14 00.23	EXTERIOR SIGNAGE - TYPE AS SCHEDULED
10 14 00.24	PERFORATED METAL EXTERIOR SIGN - TYPE AS SCHEDULED
10 14 00.30	WALL MOUNTING BRACKET
10 14 00.31	EXPANSION BOLT
10 14 00.40	FABRIC BANNER - INTERIOR
10 14 00.41	FABRIC BANNER - EXTERIOR

10 14 00.45	TV STUDIO "ON-AIR" SIGN
10 21 13	**TOILET COMPARTMENTS**
10 21 13.01	TOILET COMPARTMENT
10 21 13.11	TOILET PARTITION - PANEL
10 21 13.12	TOILET PARTITION - POST - FLOOR TO CEILING
10 21 13.13	TOILET PARTITION - WALL BRACKET
10 21 13.21	TOILET COMPARTMENT DOOR - 36 INCH
10 21 13.22	TOILET COMPARTMENT DOOR - 28 INCH
10 21 13.31	URINAL SCREEN
10 21 13.41	PRIVACY PARTITION - 30 INCHES WIDE x 48 INCHES TALL - MOUNT 24 INCHES ABOVE FINISH FLOOR
10 21 23	**CUBICLES**
10 21 23.01	CURTAIN TRACK AND CURTAIN
10 21 23.11	CURTAIN TRACK AND CURTAIN - ART
10 22 13	**WIRE MESH PARTITIONS**
10 22 13.01	WIRE MESH PARTITION - FLOOR TO SOFFIT
10 22 13.11	WIRE MESH PARTITION FRAME
10 22 13.12	WIRE MESH PARTITION DOOR
10 22 23	**WALL SCREENS**
10 22 23.01	WALL SCREEN - TYPE I - 29'-6" W x 23'-4" H
10 22 23.02	WALL SCREEN - TYPE II - 27'-0" W x 24'-4" H
10 22 23.03	WALL SCREEN - TYPE III - 31'-6" W x 24'-6" H
10 22 28	**FOLDING PANEL PARTITIONS**
10 22 28.01	FOLDING PANEL PARTITION
10 22 28.10	HANGING ROD
10 22 28.11	CONTINUOUS STEEL TRACK
10 22 28.12	HANGING BRACKET
10 22 28.13	CONTINUOUS STEEL SOFFIT TRIM PANEL
10 28 13	**TOILET ACCESSORIES**
10 28 13.01	TOILET ACCESSORY - SEE SCHEDULE
10 28 13.11	PAPER TOWEL DISPENSER
10 28 13.12	SOAP DISPENSER
10 28 13.13	COAT HOOK
10 44 00	**FIRE PROTECTION SPECIALTIES**
10 44 00.01	FIRE EXTINGUISHER CABINET - FULLY RECESSED
10 44 00.02	FIRE EXTINGUISHER AND BLANKET CABINET - FULLY RECESSED
10 44 00.03	FIRE EXTINGUISHER WALL MOUNTED BRACKET
10 44 00.11	FIRE EXTINGUISHER
10 44 00.12	FIRE BLANKET
10 44 00.21	EMERGENCY KEY CABINET
10 44 00.31	FIRST AID KIT - WALL MOUNTED
10 51 13	**METAL LOCKERS**
10 51 13.01	METAL LOCKER - SLOPED TOP - TYPE 1
10 51 13.02	METAL LOCKER - SLOPED TOP - TYPE 2
10 51 13.03	METAL LOCKER - SLOPED TOP - TYPE 3
10 51 13.04	METAL LOCKER - SLOPED TOP - TYPE 4
10 51 13.05	METAL LOCKER - SLOPED TOP - TYPE 5
10 51 13.06	METAL LOCKER - SLOPED TOP - TYPE 6
10 51 13.07	METAL LOCKER - SLOPED TOP - TYPE 7
10 51 13.08	METAL LOCKER - SLOPED TOP - TYPE 8
10 51 13.09	METAL LOCKER - SLOPED TOP - TYPE 9
10 51 13.10	METAL LOCKER - FLAT TOP - TYPE 10
10 51 13.20	METAL FILLER PANEL - EACH SIDE OF LOCKER BANK TO CENTER LOCKERS IN OPENING
10 51 13.21	LOCKER ROOM BENCH
10 71 13	**EXTERIOR SUN CONTROL DEVICES**
10 71 13.01	ALUMINUM SUNSHADE ASSEMBLY
10 71 13.10	ALUMINUM SUNSHADE OUTRIGGER
10 71 13.11	ALUMINUM SUNSHADE KNIFE PLATE
10 71 13.12	ALUMINUM SUNSHADE BRACKET
10 71 13.13	ALUMINUM SUNSHADE FASCIA
10 71 13.14	ALUMINUM SUNSHADE BLADE - 1 1/2" DIAMETER
10 71 13.15	ALUMINUM SUNSHADE BLADE - 2 1/2" DIAMETER
10 71 13.16	ALUMINUM MESH - PATTERN CHOSEN BY ARCHITECT

10 71 13.17 ALUMINUM SUNSHADE SUPPORT ROD
10 71 13.18 ALUMINUM SUNSHADE TURNBUCKLE

10 71 13.99 SEALANT - TYPE AS REQUIRED

DIVISION 11 - EQUIPMENT

11 13 00 LOADING DOCK EQUIPMENT

11 13 00.01 DOCK BUMPERS
11 13 00.02 RUBBER CORNER GUARD

11 31 00 RESIDENTIAL APPLIANCES

11 31 00.01 REFRIGERATOR
11 31 00.02 REFRIGERATOR - UNDER-COUNTER
11 31 00.03 REFRIGERATOR/FREEZER - UNDER-COUNTER

11 31 00.11 DISHWASHER - UNDER-COUNTER

11 31 00.21 WASHER
11 31 00.22 DRYER
11 31 00.23 STORAGE DRAWER PEDESTAL

11 31 00.25 HEAVY-DUTY WASHER
11 31 00.26 HEAVY-DUTY DRYER

11 31 00.31 ICE MACHINE - UNDER-COUNTER

11 31 00.40 MICROWAVE - BUILT-IN
11 31 00.41 WALL OVEN-BUILT-IN ELECTRIC
11 31 00.42 IN COUNTER COOKTOP - ELECTRIC
11 31 00.43 IN COUNTER COOKTOP - GAS
11 31 00.44 GAS COOKTOP MODULE
11 31 00.45 SLIDE IN RANGE - GAS
11 31 00.46 RANGE HOOD
11 31 00.47 GAS COOKTOP GRILL MODULE

11 40 00 FOODSERVICE EQUIPMENT

11 40 00.01 FOODSERVICE EQUIPMENT - SEE FOODSERVICE SPECIFICATION AND DRAWINGS
11 40 00.11 EXHAUST VENTILATOR - REFER TO FOODSERVICE EQUIPMENT DRAWINGS AND SPECIFICATIONS
11 40 00.12 CLOSURE PANEL BY KITCHEN EQUIPMENT CONTRACTOR

11 40 00.20 REFRIGERATOR / FREEZER - SEE FOODSERVICE SPECIFICATION
11 40 00.21 REFRIGERATOR / REFRIGERATOR - SEE FOODSERVICE SPECIFICATION
11 40 00.22 FREEZER / FREEZER - SEE FOODSERVICE SPECIFICATION
11 40 00.23 REFRIGERATOR / REFRIGERATOR / FREEZER - SEE FOODSERVICE SPECIFICATION
11 40 00.24 FREEZER - SEE FOOD SERVICE SPECIFICATION

11 40 00.30 COMMERCIAL HOOD

11 51 19 BOOK THEFT PROTECTION EQUIPMENT
11 51 19.01 BOOK CHECK UNIT
11 51 19.02 DETECTION SYSTEM

11 52 13 PROJECTION SCREENS

11 52 13.01 PROJECTION SCREEN - TYPE 1
11 52 13.02 PROJECTION SCREEN - TYPE 2
11 52 13.03 PROJECTION SCREEN - TYPE 3

11 52 13.10 PROJECTOR LIFT

11 53 00 LABORATORY EQUIPMENT

11 53 00.01 GOGGLE CABINET
11 53 00.02 MICROSCOPE CABINET

11 53 00.15 ACID STORAGE CABINET - TYPE 1
11 53 00.16 ACID STORAGE CABINET - TYPE 2
11 53 00.17 ACID STORAGE CABINET - TYPE 3
11 53 00.18 FLAMMABLE STORAGE CABINET - TYPE 1

11 53 00.21 WATER DISTILLER

11 53 00.31 AUTOCLAVE STERILIZER

11 53 00.41 INCUBATOR

11 53 00.52 GLASSWARE PEGBOARD @ SUPPORT BRACKETS

11 53 00.61 STREAM TABLE

11 53 13 LABORATORY FUME HOODS

11 53 13.01 FUME HOOD - TYPE 1
11 53 13.02 FUME HOOD - TYPE 2

11 53 13.10 SERVICE AND WATER FITTINGS

11 57 00 VOCATIONAL SHOP EQUIPMENT

11 57 00.01 SHOP EQUIPMENT - REFERENCE SCHEDULE AND SPECIFICATION

11 61 00 THEATER AND STAGE EQUIPMENT

11 61 00.01 DIMMING RACK
11 61 00.02 DIMMING CONSOLE
11 61 00.03 LIGHTING CONSOLE
11 61 00.04 STAGE MANAGER PANEL
11 61 00.05 TORM LADDER
11 61 00.06 STAGE RIGGING
11 61 00.07 CURTAIN - MAIN VALANCE
11 61 00.08 CURTAIN - MAIN TRAVELER
11 61 00.09 CURTAIN - BORDER
11 61 00.10 CURTAIN - LEG
11 61 00.11 CURTAIN - TRAVELER
11 61 00.12 CURTAIN - CYCLORAMA
11 61 00.13 CURTAIN - SIDE TABS

11 61 00.20 TV STUDIO PIPE GRID
11 61 00.21 TV STUDIO CURTAIN ASSEMBLY
11 61 00.22 STEEL ANGLES WITH PRE-PUNCHED HOLES - SIZE AND GAGE AS REQUIRED
11 61 00.23 STAINLESS STEEL ROD - 3/16 INCH DIAMETER
11 61 00.24 STAINLESS STEEL BOLT AND WASHERS

11 61 00.30 GROUP SEMINAR PIPE GRID
11 61 00.31 GROUP SEMINAR CURTAIN ASSEMBLY

11 61 00.41 GRAPHIC DESIGN CLASSROOM PIPE GRID

11 66 23 GYMNASIUM EQUIPMENT

11 66 23.01 WALL PADDING - TYPE 1
11 66 23.02 WALL PADDING - TYPE 2
11 66 23.11 VOLLEYBALL STANDARD FLOOR INSERT
11 66 23.21 MAT HOIST - TYPE 1
11 66 23.22 MAT HOIST - TYPE 2
11 66 23.31 BATTING CAGE
11 66 23.41 MAT STORAGE RACK

11 66 24 BASKETBALL GYM EQUIPMENT

11 66 24.01 BACKSTOP - FORWARD FOLDING - ADJUSTABLE CEILING MOUNTED - ELECTRIC OPERATED
11 66 24.21 BACKBOARD - GLASS - OFFICIAL 72 x 48 - SAFETY PADDING
11 66 24.31 WINCH

11 66 53 GYMNASIUM DIVIDERS

11 66 53.01 ROLL-FOLD DIVIDER CURTAIN - OVERHEAD SUPPORTED
11 66 53.02 ROLL-FOLD DIVIDER CURTAIN - OVERHEAD SUPPORTED - GRAPHIC PRINTED
11 66 53.11 DIVIDER CURTAIN MOTOR

DIVISION 12 - FURNISHINGS

12 24 00 WINDOW SHADES

12 24 00.01 ROLLER SHADE
12 24 00.02 BLACKOUT SHADE
12 24 00.03 BLACKOUT SHADE - ELECTRICALLY OPERATED
12 24 00.04 DUAL ROLLER SHADES

12 30 00 CASEWORK

12 30 00.01 BASE CABINET
12 30 00.02 WALL CABINET
12 30 00.03 TALL CABINET
12 30 00.10 LOCKING NARCOTICS CABINET

12 30 00.20 PLASTIC LAMINATE COUNTERTOP
12 30 00.21 PLASTIC LAMINATE BACKSPLASH - 4 INCH
12 30 00.22 PVC EDGE BANDING
12 30 00.23 PLASTIC LAMINATE BACKSPLASH - 6 INCH
12 30 00.24 PLASTIC LAMINATE BACKSPLASH - 8 INCH
12 30 00.25 PLASTIC LAMINATE COUNTERTOP - HIGH WEAR
12 30 00.26 PLASTIC LAMINATE BACKSPLASH - 2 INCH
12 30 00.28 STAINLESS STEEL COUNTERTOP
12 30 00.29 STAINLESS STEEL COUNTERTOP AND 4 INCH BACKSPLASH

12 30 00.30 GROMMET - 3 INCH - PLASTIC
12 30 00.31 STEEL UNDER COUNTER SUPPORT BRACKET - SIZE AS NOTED OR DRAWN
12 30 00.32 LOCK

12 30 00.50 FILLER PIECE SCRIBED TO ADJACENT SURFACE - FINISH TO MATCH CASEWORK

12 30 00.60 4" WOOD VALANCE-CONTINUOUS - FINISH TO MATCH CASEWORK
12 30 00.61 WOOD END PANEL - FINISH TO MATCH CASEWORK
12 30 00.62 1 INCH THICK FINISHED PANEL TO MATCH CASEWORK
12 30 00.65 RESIN LABORATORY COUNTERTOP AND BACKSPLASH WITH LIPPED MARINE EDGES AND INTEGRAL DRIP EDGE BE
12 30 00.66 RESIN LABORATORY SHELF WITH LIPPED MARINE EDGES AND INTEGRAL DRIP EDGE BELOW

12 35 51 MUSICAL INSTRUMENT STORAGE CASEWORK

12 35 51.01 MUSICAL INSTRUMENT STORAGE SYSTEM
12 35 51.10 MUSIC LIBRARY STORAGE SYSTEM

12 48 13 ENTRANCE FLOOR MATS AND FRAMES

12 48 13.01 RECESSED ENTRANCE GRATING - REFERENCE DRAWINGS FOR SIZE
12 48 13.02 RECESSED ENTRANCE MAT - REFERENCE DRAWINGS FOR SIZE
12 48 13.05 EXTRUDED ALUMINUM RECESSED FRAMING - Z SHAPE
12 48 13.10 EXTRUDED ALUMINUM RECESSED FRAMING - L SHAPE

12 61 00 FIXED AUDIENCE SEATING

12 61 00.01 FIXED AUDIENCE SEAT
12 61 00.02 FIXED AUDIENCE SEAT WITH LIGHT UNDER ARMREST
12 61 00.03 FIXED AUDIENCE SEAT - ADA ACCESSIBLE ARMLESS SEAT

12 61 00.11 FIXED AUDIENCE SEAT - GROUP SEMINAR

12 66 13 TELESCOPING BLEACHERS

12 66 13.01 TELESCOPING POWER ASSISTED WOOD BLEACHERS
12 66 13.02 BLEACHER GRAPHIC LOGO
12 66 13.03 PORTABLE TELESCOPING MANUAL WOOD BLEACHERS

12 66 13.11 TELESCOPING POWER ASSISTED AUDIENCE SEATING
12 66 13.12 TELESCOPING MANUAL AUDIENCE SEATING

12 66 13.21 PORTABLE FOLDING CHAIR

12 68 00 SEAT AND TABLE ASSEMBLIES

12 68 00.01 FIXED SEATING AND TABLES

DIVISION 13 - SPECIAL CONSTRUCTION

13 31 23 TENSIONED FABRIC STRUCTURES

13 31 23.01 TENSIONED FABRIC STRUCTURE

13 31 23.11 FABRIC
13 31 23.12 FABRIC REINFORCEMENT LOOP
13 31 23.13 FABRIC VOID FOR UTILITY INSTALLATION

13 31 23.21 STRUCTURAL CABLE - SEWN INTO FABRIC
13 31 23.22 CABLE TERMINATION CLEVIS - STAINLESS STEEL

13 31 23.31 STRUCTURAL TUBE - 3 INCH x 3 INCH - STAINLESS STEEL
13 31 23.32 CLOSURE PLATE - STAINLESS STEEL
13 31 23.33 STRUCTURAL TUBE - 2 INCH x 2 INCH - STAINLESS STEEL
13 31 23.34 STAINLESS STEEL NUT AND WASHER
13 31 23.35 STAINLESS STEEL NUT AND WASHER - GRIND ROD SMOOTH TO NUT
13 31 23.36 STAINLESS STEEL CORNER PLATE - 3/4 INCH THICK MINIMUM

13 31 23.41 STEEL ROD
13 31 23.42 STEEL ROD CLEVIS
13 31 23.43 STEEL SECUREMENT PLATE

13 34 00 PRE-ENGINEERED BUILDING

13 34 00.01 PRE-ENGINEERED BUILDING
13 34 00.02 COLUMN
13 34 00.03 RAFTER
13 34 00.04 PURLIN

13 34 00.11 INSULATED WALL PANEL - VERTICAL MINOR FLUTES
13 34 00.12 EAVE EXTERNAL CLOSURE
13 34 00.13 BASE INTERNAL CLOSURE

13 34 00.21 INSULATED ROOF PANEL - INTERLOCKING MECHANICAL STANDING SEAM
13 34 00.22 EAVE GUTTER - SEAMLESS
13 34 00.23 GUTTER STRAP 3 FEET O.C. MAX
13 34 00.24 DOWNSPOUT
13 34 00.25 SNOWGUARDS

13 34 00.31 EXPANSION RIDGE FLASHING
13 34 00.32 EXTERIOR METAL RIDGE CLOSURE
13 34 00.33 RIDGE FASTENER

13 34 00.41 EAVE FLASHING
13 34 00.42 BASE FLASHING

13 34 00.43	BASE ANGLE
13 34 00.44	BASE PARAPET FLASHING
13 34 00.51	SEALANT - CONTINUOUS
13 34 00.61	ALUMINUM WINDOW
13 34 00.62	ALUMINUM WINDOW FRAME
13 34 00.63	ALUMINUM WINDOW SASH
13 34 00.71	STOREFRONT DOOR AND FRAME
13 34 00.72	STOREFRONT FRAME
13 34 00.73	STOREFRONT DOOR
13 34 00.81	HOLLOW METAL DOOR AND FRAME
13 34 00.82	HOLLOW METAL FRAME
13 34 00.83	HOLLOW METAL DOOR

DIVISION 14 - CONVEYING SYSTEM

14 21 23	**COMPACT TRACTION ELEVATORS**
14 21 23.01	ELEVATOR TYPE 1- SEE SPECIFICATION
14 21 23.02	ELEVATOR TYPE 2- SEE SPECIFICATION
14 21 23.03	ELEVATOR TYPE 3- SEE SPECIFICATION
14 21 23.11	ELEVATOR CAB
14 21 23.12	ELEVATOR PLATFORM
14 21 23.13	ELEVATOR SILL
14 21 23.14	ELEVATOR DOOR FRAME
14 21 23.15	ELEVATOR DOORS
14 21 23.16	ELEVATOR DOOR GUIDE
14 21 23.17	ELEVATOR GUIDE RAILS AND BRACKETS
14 21 23.21	STEEL SILL GUARDS
14 21 23.22	SHIM

DIVISION 15 - RESERVED

15 00 00	**NOT USED**
15 00 00.01	NOT USED

DIVISION 16 - RESERVED

16 00 00	**NOT USED**
16 00 00.01	NOT USED

DIVISION 17 - RESERVED

17 00 00	**NOT USED**
17 00 00.01	NOT USED

DIVISION 18 - RESERVED

18 00 00	**NOT USED**
18 00 00.01	NOT USED

DIVISION 19 - RESERVED

19 00 00	**NOT USED**
19 00 00.01	NOT USED

DIVISION 20 - RESERVED

20 00 00	**NOT USED**
20 00 00.01	NOT USED

DIVISION 21 - FIRE SUPPRESSION

21 00 00	**FIRE SUPPRESSION**
21 00 00.01	SPRINKLER HEAD - PENDANT
21 00 00.02	SPRINKLER HEAD - UPRIGHT
21 00 00.03	SPRINKLER HEAD - RECESSED
21 00 00.04	SPRINKLER HEAD - SIDEWALL
21 00 00.05	FIRE STANDPIPE
21 00 00.06	SPRINKLER PIPE
21 00 00.07	FIRE DEPARTMENT VALVE / CABINET
21 00 00.08	FIRE DEPARTMENT VALVE

21 00 00.09	FIRE DEPARTMENT CONNECTION
21 00 00.10	VALVE AND EXTINGUISHER CABINET
21 00 00.12	FIRE HOSE CABINET

DIVISION 22 - PLUMBING

22 00 00	**PLUMBING**
22 00 00.01	SINK - SEE PLUMBING
22 00 00.02	LAVATORY - SEE PLUMBING
22 00 00.03	WATER FOUNTAIN - SEE PLUMBING
22 00 00.04	ELECTRIC WATER COOLER - SEE PLUMBING
22 00 00.05	WATER CLOSET - SEE PLUMBING
22 00 00.06	URINAL - SEE PLUMBING
22 00 00.07	SHOWER - SEE PLUMBING
22 00 00.08	MOP RECEPTOR - SEE PLUMBING
22 00 00.09	HOSE REEL ASSEMBLY - SEE PLUMBING
22 00 00.10	HOSE BIB - SEE PLUMBING
22 00 00.11	MOP SINK - SEE PLUMBING
22 00 00.12	HYDRATION STATION - SEE PLUMBING
22 00 00.15	COMPRESSED AIR SUPPLY VALVE - SEE PLUMBING
22 00 00.20	ROOF DRAIN ASSEMBLY - SEE PLUMBING
22 00 00.21	FLOOR DRAIN - SEE PLUMBING
22 00 00.22	DRAIN PIPE - SEE PLUMBING
22 00 00.23	AREA DRAIN - SEE PLUMBING
22 00 00.24	TRENCH DRAIN - SEE PLUMBING
22 00 00.30	PIPE INSULATION - SEE PLUMBING
22 00 00.35	RAIN WATER LEADER - SEE PLUMBING
22 00 00.40	FREEZE PROOF WALL HYDRANT - SEE PLUMBING
22 00 00.50	PIPE PENETRATION - SEE PLUMBING
22 00 00.60	PIPE - SEE PLUMBING
22 00 00.70	EMERGENCY EYEWASH/SHOWER STATION - SEE PLUMBING
22 00 00.71	EMERGENCY UTILITY CONTROLLER - SEE PLUMBING
22 00 00.72	EMERGENCY EYEWASH STATION - SEE PLUMBING
22 00 00.73	MASTER GAS SHUT-OFF VALVE - SEE PLUMBING
22 00 00.80	GAS METER - SEE PLUMBING
22 00 00.98	SHOWER HEAD & FAUCET - SEE PLUMBING
22 00 00.99	RESIDENTIAL SHOWER / TUB - SEE PLUMBING

DIVISION 23 - HEATING, VENTILATING AND AIR CONDITIONING

23 00 00	**HEATING, VENTILATING, AND AIR CONDITIONING**
23 00 00.01	CONVECTOR - SEE HVAC
23 00 00.02	DIFFUSER - SEE HVAC
23 00 00.03	CABINET UNIT HEATER - SEE HVAC
23 00 00.04	PTAC UNIT - SEE HVAC
23 00 00.06	ROOF TOP UNIT - SEE HVAC
23 00 00.08	BOILER STACK - SEE HVAC
23 00 00.10	FAN - SEE HVAC
23 00 00.12	EXHAUST FAN UNIT - SEE HVAC
23 00 00.14	VENT - SEE HVAC
23 00 00.20	SUPPLY AIR REGISTER - SEE HVAC
23 00 00.21	RETURN AIR REGISTER - SEE HVAC
23 00 00.22	AIR PLENUM - SEE HVAC
23 00 00.23	DUCT - SEE HVAC
23 00 00.24	FLEXIBLE AIR DUCT - SEE HVAC
23 00 00.25	RADIANT PANEL - SEE HVAC
23 00 00.30	STAINLESS STEEL EXHAUST HOOD -SEE HVAC
23 00 00.35	DESTRATIFICATION FAN - SEE HVAC
23 00 00.40	VEHICLE EXHAUST SYSTEM - SEE HVAC
23 00 00.41	VEHICLE EXHAUST SYSTEM ACCESS DOOR - SEE HVAC
23 00 00.50	DUST COLLECTOR - SEE HVAC

DIVISION 24 - RESERVED

24 00 00	**NOT USED**
24 00 00.01	NOT USED

DIVISION 25 - INTEGRATED AUTOMATION

25 00 00	**NOT USED**
25 00 00.01	NOT USED

DIVISION 26 - ELECTRICAL

26 00 00	**ELECTRICAL**
26 00 00.01	LIGHT FIXTURE - SEE ELECTRICAL
26 00 00.02	COVE LIGHT FIXTURE - SEE ELECTRICAL
26 00 00.03	2x4 FLUORESCENT LIGHT FIXTURE
26 00 00.04	2x2 FLUORESCENT LIGHT FIXTURE
26 00 00.05	1x4 FLUORESCENT LIGHT FIXTURE

26 00 00.06	8' LONG PENDANT LIGHT FIXTURE
26 00 00.07	4' LONG PENDANT LIGHT FIXTURE
26 00 00.08	4' FLUORESCENT INDUSTRIAL LIGHT FIXTURE
26 00 00.09	DOWN LIGHT
26 00 00.10	WALL MOUNTED LIGHT
26 00 00.11	PENDANT LIGHT FIXTURE
26 00 00.12	UNDER-COUNTER LIGHT - SEE ELECTRICAL
26 00 00.13	EXTERIOR LIGHT FIXTURE - SEE ELECTRICAL
26 00 00.15	UNDER SLAB CONDUIT - SEE ELECTRICAL
26 00 00.16	ELECTRICAL CONDUIT - SEE ELECTRICAL
26 00 00.21	CEILING MOUNTED SPEAKER BAFFLE - SEE ELECTRICAL
26 00 00.22	FIRE ALARM ANNUNCIATOR PANEL
26 00 00.23	FIRE ALARM AUDIO/VISUAL UNIT - SEE ELECTRICAL
26 00 00.24	FIRE ALARM PULL - SEE ELECTRICAL
26 00 00.25	EXIT SIGN - SEE ELECTRICAL
26 00 00.26	FIRE ALARM CONTROL PANEL - SEE ELECTRICAL
26 00 00.30	SCOREBOARD - SEE ELECTRICAL
26 00 00.31	TV STUDIO "ON AIR" SIGN
26 00 00.40	RACEWAY G6400 - UNDER SHELF OVER COUNTER - SEE ELECTRICAL
26 00 00.45	SURFACE MTD JUNCTION BOX AND CONDUIT FOR SOUND SYSTEM - SEE ELECTRICAL
26 00 00.50	ELECTRICAL OUTLET - SEE ELECTRICAL
26 00 00.51	ELECTRICAL FLOOR OUTLET - SEE ELECTRICAL
26 00 00.52	LIGHT SWITCH - SEE ELECTRICAL
26 00 00.53	ELECTRICAL RETRACTABLE OVERHEAD OUTLET - SEE ELECTRICAL
26 00 00.54	ELECTRICAL OUTLET WITH DIRECT CURRENT - SEE ELECTRICAL
26 00 00.60	LCD ANNUNCIATOR
26 00 00.65	TV MONITOR- N.I.C.
26 00 00.66	SECURITY KEYPAD
26 00 00.67	CARD READER
26 00 00.70	EXTERIOR WALL MOUNTED SPEAKER
26 00 00.72	ELECTRICAL POWER PANELS - SEE ELECTRICAL
26 00 00.75	EMERGENCY LIGHTING
26 00 00.80	SOLAR PANEL - SEE ELECTRICAL
26 00 00.81	SOLAR PANEL RACK - SEE ELECTRICAL
26 00 00.76	SECURITY STROBE
26 00 00.98	EMERGENCY SHUT OFF - SEE ELECTRICAL
26 00 00.99	ELECTRICAL PANEL - SEE ELECTRICAL

DIVISION 27 - COMMUNICATIONS

27 10 00 STRUCTURED CABLING

27 10 00.01	CPU HOLDER - SEE TECHNOLOGY
27 10 00.02	MONITOR ARM - SEE TECHNOLOGY
27 10 00.10	DATA OUTLET - SEE TECHNOLOGY
27 10 00.20	EDUCATION FOR SUSTAINABILITY SYSTEM - SEE TECHNOLOGY

27 21 00 DATA COMMUNICATIONS NETWORK EQUIPMENT

27 21 00.01	ANTENNA - SEE TECHNOLOGY

27 40 00 AUDIO-VIDEO COMMUNICATIONS

27 40 00.02	CAMERA - SEE TECHNOLOGY
27 40 00.03	VIDEO DISPLAY MONITOR
27 40 00.04	VIDEO DISPLAY WALL BRACKET
27 40 00.06	SPEAKER - SEE TECHNOLOGY
27 40 00.07	EQUIPMENT RACK
27 40 00.08	PROJECTOR - SEE TECHNOLOGY
27 40 00.10	FACE PLATE - SEE TECHNOLOGY

27 50 00 DISTRIBUTED COMMUNICATIONS AND MONITORING

27 50 00.01	SPEAKER - SEE TECHOLOGY
27 50 00.11	CLOCK - SEE TECHNOLOGY

27 70 00 VIDEO DISTRIBUTION SYSTEM

27 70 00.01	TV - FLAT SCREEN - SEE TECHNOLOGY

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

28 13 00 ACCESS CONTROL

28 13 00.01	NOT USED

28 16 00 INTRUSION DETECTION

28 16 00.01	MOTION SENSOR - SEE TECHNOLOGY

28 23 00 VIDEO SURVEILLANCE

28 23 00.01	CAMERA - SEE TECHNOLOGY

DIVISION 29 - RESERVED

29 00 00 **NOT USED**

29 00 00.01 NOT USED

DIVISION 30 - RESERVED

30 00 00 **NOT USED**

30 00 00.01 NOT USED

DIVISION 31 - EARTHWORK

31 00 00 **NOT USED**

31 00 00.01 NOT USED

DIVISION 32 - EXTERIOR IMPROVEMENTS

32 13 13 **SITE CONCRETE**

32 13 13.01 SIDEWALK - SEE CIVIL/LANDSCAPE
32 13 13.02 BOND BREAKER

DIVISION 33 - UTILITIES

33 00 00 **NOT USED**

33 00 00.01 NOT USED

DIVISION 34 - TRANSPORTATION

34 00 00 **NOT USED**

34 00 00.01 NOT USED

DIVISION 35 - WATERWAY AND MARINE CONSTRUCTION

35 00 00 **NOT USED**

35 00 00.01 NOT USED

APPENDIX B

LEED SCORECARD

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LEED 2009 for Schools New Construction and Major Renovations

Project Scorecard :

Plymouth South High School

05.21.15

Sustainable Sites — Possible Points: 24

Y	?	N				
13	0	-				
Y			C	Prereq 1	Construction Activity Pollution Prevention	
Y			d	Prereq 2	Environmental Site Assessment	
1			d	Credit 1	Site Selection	1
		X	d	Credit 2	Development Density and Community Connectivity	4
1			d	Credit 3	Brownfield Redevelopment	1
		X	d	Credit 4.1	Alternative Transportation—Public Transportation Access	4
		X	d	Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1
2			d	Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	2
2			d	Credit 4.4	Alternative Transportation—Parking Capacity	2
1			C	Credit 5.1	Site Development—Protect or Restore Habitat	1
1			d	Credit 5.2	Site Development—Maximize Open Space	1
1			d	Credit 6.1	Stormwater Design—Quantity Control	1
1			d	Credit 6.2	Stormwater Design—Quality Control	1
		X	C	Credit 7.1	Heat Island Effect—Non-roof	1
1			d	Credit 7.2	Heat Island Effect—Roof	1
1			d	Credit 8	Light Pollution Reduction	1
		X	d	Credit 9	Site Master Plan	1
1			d	Credit 10	Joint Use of Facilities	1

Water Efficiency — Possible Points: 11

Y	?	N				
7	1	-				
Y			d	Prereq 1	Water Use Reduction—20% Reduction	
2			d	Credit 1	Water Efficient Landscaping	2 to 4
2			d	Credit 2	Innovative Wastewater Technologies	2
3	1		d	Credit 3	Water Use Reduction	2 to 4
		X	d	Credit 4	Process Water Use Reduction	1

Energy and Atmosphere — Possible Points: 33

Y	?	N				
10	1	-				
Y			C	Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			d	Prereq 2	Minimum Energy Performance	
Y			d	Prereq 3	Fundamental Refrigerant Management	
7	1		d	Credit 1	Optimize Energy Performance	1 to 19
		X	d	Credit 2	On-Site Renewable Energy	1 to 7
2			C	Credit 3	Enhanced Commissioning	2
1			d	Credit 4	Enhanced Refrigerant Management	1
		X	C	Credit 5	Measurement and Verification	1 to 2
		X	C	Credit 6	Green Power	2

Materials and Resources — Possible Points: 13

Y	?	N				
6	1	-				
Y			d	Prereq 1	Storage and Collection of Recyclables	
		X	C	Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 2
		X	C	Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elements	1
2			C	Credit 2	Construction Waste Management	1 to 2

Materials and Resources — Possible Points: 13

Y	?	N				
		X	C	Credit 3	Materials Reuse	1 to 2
2			C	Credit 4	Recycled Content	1 to 2
1	1		C	Credit 5	Regional Materials	1 to 2
		X	C	Credit 6	Rapidly Renewable Materials	1
1			C	Credit 7	Certified Wood	1

Indoor Environmental Quality — Possible Points: 19

Y	?	N				
14	0	-				
Y			d	Prereq 1	Minimum Indoor Air Quality Performance	
Y			d	Prereq 2	Environmental Tobacco Smoke (ETS) Control	
Y			d	Prereq 3	Minimum Acoustical Performance	
		X	d	Credit 1	Outdoor Air Delivery Monitoring	1
		X	d	Credit 2	Increased Ventilation	1
1			C	Credit 3.1	Construction IAQ Management Plan—During Construction	1
1			C	Credit 3.2	Construction IAQ Management Plan—Before Occupancy	1
4			C	Credit 4	Low-Emitting Materials	1 to 4
1			d	Credit 5	Indoor Chemical and Pollutant Source Control	1
1			d	Credit 6.1	Controllability of Systems—Lighting	1
1			d	Credit 6.2	Controllability of Systems—Thermal Comfort	1
1			d	Credit 7.1	Thermal Comfort—Design	1
1			d	Credit 7.2	Thermal Comfort—Verification	1
1			d	Credit 8.1	Daylight and Views—Daylight	1 to 3
		X	d	Credit 8.2	Daylight and Views—Views	1
1			d	Credit 9	Enhanced Acoustical Performance	1
1			C	Credit 10	Mold Prevention	1

Innovation and Design Process — Possible Points: 6

Y	?	N				
3	2	-				
1			d	Credit 1.1	Innovation in Design or Exemplary Performance Credit or Pilot Credit	1
1			d	Credit 1.2	Innovation in Design or Exemplary Performance Credit or Pilot Credit	1
	1		C	Credit 1.3	Innovation in Design or Exemplary Performance Credit or Pilot Credit	1
		X	d	Credit 1.4	Innovation in Design or Exemplary Performance Credit or Pilot Credit	1
1			d	Credit 2	LEED Accredited Professional	1
	1		d	Credit 3	The School as a Teaching Tool	1

Regional Priority Credits — Possible Points: 4

Y	?	N				
4	0	-				
1			d	Credit 1.1	Regional Priority: SSc1: Site Selection	1
1			d	Credit 1.2	Regional Priority: SSc5.1: Site Development - Protect or Restore Habitat	1
1			d	Credit 1.3	Regional Priority: SSc6.2: Stormwater Design - Quality Control	1
1			d	Credit 1.4	Regional Priority: WEc3: Water Use Reduction	1

Total — Possible Points: 110

Y	?	N
57	5	-

Certified 40 to 49 points **Silver 50 to 59 points** Gold 60 to 79 points Platinum 80 to 110

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APPENDIX C

GEOTECHNICAL REPORT

AND

LOGS OF ADDITIONAL BORINGS

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September 8, 2014

Mr. L. Scott Dunlap, AIA
Ai3 Architects LLC
526 Boston Post Road
Wayland, MA 01778
phone: (508) 358-0790
fax: (508) 358-0791

Re: Geotechnical Report
Proposed Plymouth South High School
Plymouth, Massachusetts
LGCI Project No. 1408

Dear Mr. Dunlap:

Lahlaf Geotechnical Consulting, Inc. (LGCI) is pleased to submit our geotechnical report for the proposed Plymouth South High School in Plymouth, Massachusetts. We are submitting our geotechnical report electronically.

The soil samples from our explorations are currently stored at LGCI for further analysis, if requested. Unless notified otherwise, we will dispose of the soil samples after three months.

Thank you for choosing LGCI as your geotechnical engineer.

Very truly yours,

Lahlaf Geotechnical Consulting, Inc.

Abdelmadjid M. Lahlaf, Ph.D., P.E.
Principal Engineer

cc. (via e-mail) Ms. Cari Orsi / Pare Corporation
Mr. James Jordan / Ai3 Architects LLC

LGCI
Lahlaf Geotechnical Consulting, Inc.

GEOTECHNICAL REPORT
PROPOSED PLYMOUTH SOUTH HIGH SCHOOL
PLYMOUTH, MASSACHUSETTS

LGCI Project No. 1408
September 8, 2014

Prepared for:

Ai3 ARCHITECTS LLC
526 Boston Post Road
Wayland, MA 01778
phone: (508) 358-0790
fax: (508) 358-0791

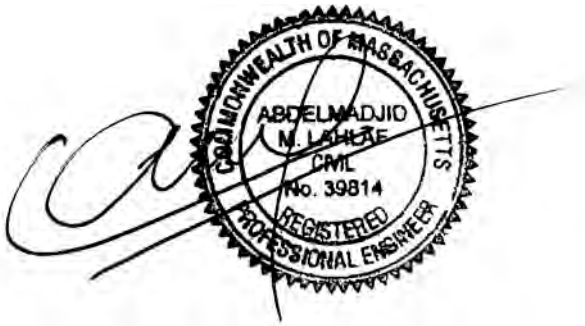
GEOTECHNICAL REPORT
PROPOSED PLYMOUTH SOUTH HIGH SCHOOL
PLYMOUTH, MASSACHUSETTS
LGCI Project No. 1408
September 8, 2014

Prepared for:

Ai3 ARCHITECTS LLC
526 Boston Post Road
Wayland, MA 01778
phone: (508) 358-0790
fax: (508) 358-0791

Prepared by:

LAHLAF GEOTECHNICAL CONSULTING, INC.
23 McGinness Way
Billerica, Massachusetts 01821
Phone: (978) 330-5912
Fax: (978) 330-5056



Abdelmadjid M. Lahlaf, Ph.D., P.E.
Principal Engineer

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Geotechnical Engineering Report
Proposed Plymouth South High School
Plymouth, Massachusetts
LGCI Project No. 1408

1. PROJECT INFORMATION

1.1 Project Authorization

This report presents the results of subsurface explorations and a geotechnical evaluation performed by Lahlaf Geotechnical Consulting, Inc. (LGCI) for the proposed Plymouth South High School in Plymouth, Massachusetts.

We performed our services in general accordance with our proposals No. 14019 and 14050 dated March 10 and July 21, 2014, respectively. Mr. Scott Dunlap of Ai3 Architect LLC (Ai3) authorized our services by signing our proposal on March 25, and July 29, 2014, respectively.

1.2 Purpose and Scope of Services

The purpose of this study was to obtain subsurface information at the site and to provide recommendations for foundation design and construction. LGCI performed the following services:

- Coordinated our field explorations with Pare Corporation, the project civil engineer, staked our exploration locations in the field, and contacted Dig Safe Systems Inc. (Dig Safe).
- Engaged an excavation subcontractor to excavate a total of twenty-four (24) test pits.
- Engaged a drilling subcontractor to drill a total of twenty-one (21) borings and to install one (1) groundwater observation well.
- Provided geotechnical field engineers at the site to coordinate and observe the borings and test pits, describe the soil samples, and prepare field logs.
- Submitted fourteen (14) soil samples for grain-size analysis.
- Prepared this geotechnical report containing the results of our subsurface explorations and our recommendations for foundation design and construction.

LGCI performed a preliminary study at the site and submitted a geotechnical report containing our preliminary foundation design and construction recommendations dated May 16, 2014. This current report contains a compilation of the results of all our explorations including those performed in the preliminary phase, and supersedes our previous report.

LGCI did not perform environmental services for this project. LGCI did not perform an assessment to evaluate the presence or absence of hazardous or toxic materials above or below the ground surface at or around the site. Any statement about the color, odor, or the presence of suspicious materials included in our boring and test pit logs or report were made by LGCI for information only and to support our geotechnical services. No environmental recommendations and/or opinions are included in this report.

Our scope did not include preparing specifications, attending meetings, performing contract document review, or providing construction services. LGCI would be pleased to perform these services, when needed, under a separate agreement. Recommendations for stormwater management, erosion control, pavement design, and detailed cost or quantity estimates are not included in our scope of work.

1.3 Site Description

Our understanding of the existing conditions is based on our field observations, our discussions with Pare Corporation, and on the following drawings:

- Drawings titled: "New Academic-Vocational High School for the Plymouth Carver Regional School Authority," (4 sheets) (Record Drawings) prepared by Day & Zimmermann of Boston, MA and dated April 1, 1985. These drawings were provided to us by the Town of Plymouth.

- Plan titled "Plymouth South HS Survey, 490 Long Pond Road, Plymouth, MA," (Survey Plan) prepared by CHA of Norwell, MA and dated January 29, 2014.

- Plan titled "Overall Site Plan," (Site Plan) prepared by Ai3 Architects / Pare Corporation and dated July 2014.

Plymouth South High School is located at 490 Long Pond Road in Plymouth, Massachusetts as shown in Figure 1. We understand that the existing school was constructed in the mid-1980s and was opened in 1988.

The site is occupied by the existing high school, parking lots, and a track and field on the southern side; and by athletic fields on the northern side. The site is bordered by Long Pond Road on the southern side, by a driveway leading to the middle school on the western side, by the middle school on the northern side, and by wooded land and Route 3 on the eastern side.

The athletic fields, where the proposed school building will be located, have a diamond shape with two baseball fields on the eastern and western corners, and two softball fields on the northern and southern corners. Soccer and football practice fields are located in the center of the athletic fields. Based on the Survey Plan, the ground surface in the athletic fields ranges between El. 211 feet near the western corner and El. 217 feet on the northeastern side. A small hill is located just east

of the athletic fields and has a local high elevation at about El. 233 feet. On the western side, the ground surface drops beyond the athletic fields over steep slopes to about El. 185 feet.

The site topography suggests that the grades were cut on the eastern side and fill was placed on the western side to create the existing athletic fields. Based on topographical information from the Record Drawings, the original grades within the existing athletic fields ranged between about El. 230 feet on the eastern side and about El. 190 near the western corner of the field; thus, indicating that cuts of up to 13 feet on the eastern side and fill up 19 feet near the western side of the athletic fields were performed during construction of the existing school and athletic fields.

1.4 Project Description

Our understanding of the proposed construction is based on our discussions with Pare Corporation, information provided to us by Ai3 during a conference call on April 16, 2014, and on the Site Plan listed in Section 1.3.

We understand that the proposed high school will be constructed in the existing athletic fields north of the existing school. The existing school will be demolished after the proposed construction is completed to allow for the construction of new athletic fields.

We understand that the proposed school will be three stories high and will have a footprint of about 160,000 square feet. The proposed school building will have a long irregular shape extending from the dirt path leading to the athletic fields on the eastern side to near the baseball field on the western side of the athletic fields. Based on information provided to us by Ai3, the proposed school building will not have a basement.

The proposed construction will also include paved parking lots on the northern and southern sides of the proposed school building, a driveway that loops around the proposed building, an addition to the waste water treatment facility, a half-time building near the northwestern corner of the track, and infiltration basins. We understand that the locations of the infiltration basins have not been selected as shown in Figure 2.

We understand that at the time of this report, the grading design was not completed. Pare Corporation indicated to us that the proposed school building will have a finished floor elevation (FFE) at about El. 214 feet. No information was available at the time of this report about the finished floor elevations at the half-time building and the waste water treatment facility addition.

1.5 Elevation Datum

We understand that the elevations shown in the Survey Plan prepared by CHA, and which we included in our boring and test pit logs, are referenced to the National Vertical Datum of 1988 (NAVD 1988). The Record Drawings referenced in Section 1.3 do not include a reference to an elevation datum.

2. SITE AND SUBSURFACE CONDITIONS

2.1 Surficial Geology

LGCI reviewed the following map:

> "Surficial geologic map of the Norton-Manomet-Westport-Sconticut Neck 23-quadrangle area in southeast Massachusetts," by Stone, B.D., Stone, J.R., DiGiacomo-Cohen, M.L., and Kincare, K.A, U.S. Geological Survey, 2011, Open-File Report 2006–1260–F.

Based on the map, the natural surficial materials at the site consist of glacial stratified deposits of sand, sand and gravel, and gravel.

The surficial geologic map is shown in Figure 3.

2.2 Subsurface Explorations

2.2.1 General

LGCI marked our test pit and boring locations in the field in the presence of representatives of Pare Corporation, Ted Gentry Associates, Inc., the Owner Project Manager, and school personnel.

LGCI provided a field engineer at the site full-time to observe the borings and the test pits, collect soil samples, and prepare field logs.

2.2.2 Test Pits

LGCI engaged J. C. Engineering, Inc. of East Wareham, Massachusetts to excavate twenty-four (24) test pits using a KUBOTA KX080 rubber-track mounted excavator. Test pits TP-1 to TP-12 were excavated on April 3 and 4, 2014 as part of our preliminary study. Test pits TP-101 to TP-112 were excavated on August 11 and 12, 2014 as part of the current study.

The test pits were advanced to depths ranging between 10 and 13.5 feet beneath the existing ground surface. The test pits were backfilled with the excavated materials. The backfill in the bottom of the test pit was placed and tamped with the excavator bucket up to a depth of 6 feet. The top 6 feet were backfilled in 12- to 18-inch lifts and were compacted with a plate compactor. Appendix A contains LGCI's test pit logs, Table 1 contains the test pit summary, and Figures 4A and 4B show the test pit locations.

We understand that the ground surface at the test pit locations was restored with loam and seed by school personnel after our field explorations.

2.2.3 Soil Borings

A total of twenty-one (21) soil borings were advanced at the site.

LGCI engaged Northern Drill Service of Northborough, Massachusetts to advance five (5) soil borings (B-1 to B-5) in the existing athletic fields between April 5 and 7, 2014 using a rubber-track mounted drill rig as part of the preliminary study. LGCI also engaged New Hampshire Boring, Inc. of Brockton, Massachusetts to advance sixteen (16) borings (B-101 to B-114, B-116 and B-117) as part of the current study. Boring B-115 was not advanced because of proximity to the existing building and the presence of utilities in the general area of the boring.

The borings were advanced using 2-¼-inch or 3-¼-inch hollow stem augers (HSAs). Borings B-3 and B-102 were started with HSAs and were completed using 4-inch cased wash-boring techniques.

The borings extended to depths ranging between 11 and 66 feet beneath the ground surface. The drillers performed Standard Penetration Tests (SPT) and obtained split spoon samples with an automatic hammer semi-continuously or at five-foot intervals as noted in the boring logs in general accordance with ASTM D-1586. Unless notified otherwise, we will dispose of the soil samples after three months.

Upon completion, the boreholes were backfilled with the soil cuttings. The drillers installed one groundwater observation well at boring B-2-OW.

Appendix B contains LGCI's boring logs and the groundwater observation well installation report, Table 2 shows the boring summary and Figures 4A and 4B show the boring locations.

The ground surface elevations shown in the test pit and boring logs were interpolated from the Survey Plan or from the Site Plan listed in Section 1.3 and are approximate.

2.3 Subsurface Conditions

The subsurface description in this report is based on a limited number of borings and test pits and is intended to highlight the major soil strata encountered during our borings and test pits. The subsurface conditions are known only at the actual boring and test pit locations. Variations may occur and should be expected between boring and test pit locations. The boring and test pit logs represent conditions that we observed at the time of our explorations and were edited, as appropriate, based on the results of the laboratory test data and inspection of the soil samples in the laboratory. The strata boundaries shown in our boring and test pit logs are based on our interpretations and the actual transition may be gradual. Graphic soil symbols are for illustration only.

The soil strata encountered in our borings and test pits were as follows, starting from the ground surface.

Topsoil/Subsoil – A layer of organic soil (topsoil/subsoil) was encountered at the ground surface in all explorations except in borings B-111 and B-114. The thickness of this layer ranged between 0.3 feet and 1.5 feet, but was mostly more than 1 foot.

Fill – Fill was encountered in all borings and in all test pits except in TP-10 to TP-12, excavated on the northeastern side of the existing athletic fields. The fill extended to depths ranging between about 0.9 and 15 feet beneath the ground surface. The thickness of the fill increased in a westerly direction, consistent with the topographic information from the Record Drawings.

The fill generally consisted of a heterogeneous mixture of poorly graded sand and silty sand with up to 30 percent fines. The fill encountered in the explorations on the western side generally contained more fines than the fill encountered on the eastern side of the athletic fields.

In test pits TP-4, TP-5, TP-7, TP-105 to TP-109, TP-111 and TP-112 excavated on the southeastern side of the athletic fields or on the southern side of site, and in in borings B-4, B-5, B-108 to B-111, B-113, and B-114 drilled on the eastern side of the fields on the southern side of the site, the fill was generally clean, i.e., did not contain organics. In test pits TP-1 to TP-3, TP-6, TP-8, TP-9, TP-101 to TP-104, and in TP-110, and in borings B-101 to B-106, the fill in the top 1.6 to 8 feet was also generally clean. The remainder of the fill in these test pits, and the entire fill layer in borings B-1 to B-3, B-107, B-112, B-116, and B-117 contained traces of organics, buried topsoil, roots, and tree stumps up to 2 feet long and between 6 and 12 in inches in diameter. A few sublayers in the fill contained between 5 percent and 10 percent cobbles as indicated in the test pit logs. At test pit TP-2, nested boulders were observed in the fill.

In general, the fill encountered in the explorations within the western half of the proposed school building and the fill encountered in the borings advanced within the proposed waste water treatment facility addition contained organics.

The standard penetration test (SPT) N-values in the fill ranged between 5 and 31 blows per foot (bpf) with most values lower than 26 bpf, indicating mostly loose to medium dense fill.

Based on the established woods around the athletic fields, i.e., within the footprint of the proposed school building, this area was likely cleared of trees when the existing athletic fields were constructed. Although LGCI did not observe evidence of a stump dump during our borings and test pits, it is not atypical for tree stumps and root balls to be dumped and buried in non-structural areas, and such dumps could exist at locations not explored by LGCI or between explorations.

Natural Sand – A layer of mostly poorly graded sand with up to 5 percent fines and up 20 percent fine gravel was encountered beneath the fill. This layer extended to the exploration termination depths, except in test pits TP-1 and TP-8 which were terminated in the fill. The SPT N-values in this layer ranged between 8 and more than 100 bpf, with most values between 10 and 49 bpf, indicating medium dense to dense sand.

2.4 Groundwater

Groundwater was observed during drilling in borings B-1, B-2, B-101 to B-105, and B-112 and during the excavation of test pits TP-1 to TP-3, TP-6, TP-8, TP-9, and TP-101 to TP-103 at depths ranging between 2 and 10 feet beneath the ground surface. These depths correspond to elevations ranging between El. 203.5 feet and El. 213.5 feet. In boring B-102, the groundwater level was encountered at 32 feet beneath the ground surface during drilling.

The soil samples in borings B-1 and B-2-OW at depths greater than 12 feet were moist and unsaturated, suggesting that the groundwater observed in the borings and test pits listed in the previous paragraph at shallower depths is perched groundwater. We believe that the water that infiltrates at the surface is trapped above the silty, slow-draining fill causing a perched condition, as evidenced by the unsaturated soil samples below a depth of 12 feet in boring B-1 and B-2-OW.

One groundwater observation well was installed in boring B-2-OW. The well was screened between depths of 7 and 17 feet beneath the ground surface. The groundwater observation well installation report is included at the end of Appendix B. The groundwater levels measured in B-2-OW after installation on April 7, and again on April 22, 2014, were 8.3 feet and 3 feet beneath the ground surface, corresponding to El. 205.7 feet and El. 211 feet, respectively. The groundwater level was 2.8 feet beneath the ground surface in B-2-OW on August 13 and 14, 2014, corresponding to El. 211.2 feet.

Based on the borings, the groundwater table in the natural sand layer is deeper than 42 feet.

The reported levels may not represent the actual groundwater conditions, as additional time may be required for the groundwater levels to stabilize. The groundwater levels presented in this report only represent the conditions encountered at the time and locations of our explorations. Seasonal fluctuation should be anticipated.

2.5 Laboratory Test Data

LGCI submitted fourteen (14) soil samples obtained from the borings and test pits for grain-size analysis. The laboratory data sheets are included in Appendix C and the results are summarized below.

Boring/ Test Pit No.	Sample Depth (ft)	Soil Layer	Percent Gravel	Percent Sand	Percent Fines
B-2	2 – 4 (Bot. 8”)	Fill	7.1	63.3	29.6
B-3	6 – 8	Natural Sand	13.8	84.6	1.6
B-103	2 – 4	Fill	5.7	87.3	7
B-111	2 – 4	Natural Sand	0.6	97.3	2.1
B-114	0.5 – 2.5	Natural Sand	-.6	96.5	2.9
B-116	5 – 7	Fill	5.8	70.6	23.6
TP-3	2 – 4	Fill	18.7	70.1	11.2
TP-5	2 – 4	Fill	17.3	80.2	2.5
TP-7	2 – 4	Fill	5	93.5	1.5
TP-12	3 – 8	Natural Sand	11.3	83.4	5.3
TP-101	4 – 5	Fill	12.1	85.6	2.3
TP-107	4 - 5	Natural Sand	11.8	87.8	0.4
TP-109	4 – 5	Natural Sand	3	96.3	0.7
TP-112	4 – 5	Natural Sand	7.7	91.1	1.2

3. EVALUATION AND RECOMMENDATIONS

3.1 Foundation Recommendations

3.1.1 General

Based on the results of the borings and test pits, the subsurface conditions at the site are suitable to support shallow foundations after the subgrade is prepared in accordance with the recommendations in this report.

The topsoil/subsoil should be removed from the entire construction area, including the proposed buildings and paved areas. The existing fill is also not suitable to support shallow foundations and should be entirely removed from under the proposed footings to the natural sand layer.

Where the fill contains organics, roots, and other deleterious matter such as encountered in the borings and test pits on the western side of the athletic fields, i.e., on the western side of the proposed school building, and in the area of the proposed waste water treatment facility, the fill is not suitable to support the proposed slab. On the eastern side of the proposed school building, where the existing fill did not generally contain organics, it can support the proposed slab after it is improved as described below.

In consideration of the above, we recommend entirely removing the existing fill from within the western portion of the proposed school building and from under the proposed waste water treatment facility addition and restoring the grades with Structural Fill. Alternatively, the existing fill should be improved using rammed aggregate piers (RAPs). On the eastern side of the proposed school building, the existing fill should be removed from under the proposed footings, but it can stay in place under the proposed slab after it is improved as described in Sections 3.2 and 4.1 of this report.

The proposed half-time building may be supported on shallow footings bearing in the natural sand.

The proposed paved areas can be constructed on the exiting fill after the topsoil/subsoil layer is removed and the top of the existing fill is improved as described in Section 4.1.

Our recommendations for the “remove and replace” improvement option and for RAPs are presented in Sections 3.1.2 and 3.1.3, respectively. Our recommendations for the design of footings and slab-on-grade are presented in Sections 3.1.4 and 3.2, respectively.

3.1.2 Remove and Replace Improvement Option

On the western side of the proposed school building and within the proposed waste water treatment facility, where the existing fill contained organics, buried topsoil, roots, and tree stumps, the existing fill should be entirely removed to the top of the natural sand and replaced with Structural Fill meeting the gradation and compaction requirements presented in Section 4.3.1. Based on the borings, the removal is anticipated to extend to depths of up to 15 feet. On the eastern side of the proposed school building, the existing fill should be removed only from under the proposed footings.

The existing fill removal should extend laterally beyond the zone of influence of footings as described in Section 4.1

To further delineate the limits of the fill that contains organics and that should be entirely removed from under the proposed school building and under the proposed waste water treatment facility, the site contractor should excavate test pits during the earthwork operations.

3.1.3 Rammed Aggregate Piers (RAPs) Improvement Option

We understand that the “remove and replace option” is being considered.

As an alternative to the “remove and replace” option, The RAP option should also be considered. The ground on the western side of the proposed school building footprint and under the proposed waste water treatment facility addition could be improved using RAPs to allow for using shallow foundations and a slab-on-grade. A few tree stumps were observed in test pits TP-1 and TP-2. Based on the number and size of the tree stumps we observed and based on our discussion with a local RAP installer, we believe that these stumps will not obstruct the installation of RAPs.

The selection of RAPs versus the “remove and replace” option should be based on a cost-benefit analysis that takes into account the cost of RAPs, the extent of removal, and whether and how much of the existing fill can be reused onsite.

RAPs are typically installed by augering 24- to 30-inch diameter holes and backfilling the holes by placing and ramming crushed stone or well graded sand with gravel. The backfill material is generally rammed/compacted in one-foot lifts, with a patented high frequency percussion hammer, to provide a firm subgrade and to compact the surrounding soil. In addition to providing a rigid column of granular material, RAPs improve the existing soil as a result of the lateral compaction that occurs during ramming of the crushed stone or well graded sand and gravel in the RAP.

Where it is not desired to generate spoils during the improvement process, vertical displacement RAPs could be used. These are installed by driving a mandrel and hammer to the design depth, feeding the backfill material through the hollow mandrel, and compacting the backfill in one-foot lifts using the hammer; thus, generating no spoils. Vertical displacement RAPs are installed with diameters ranging between 12 and 16 inches, and could be installed to depths of up to 35 feet.

In a previous communication, the project civil engineer expressed a concern about the RAP option related to the long term settlement of the foundations and floor slab as a result of the decay of the organics and tree stumps in the deeper fill. Based on our experience and on our discussion with a local contractor representative specialized in the design of RAPs, we believe that the decay of the occasional stump would not negatively impact the proposed footings or slab. We believe that local settlement that may occur as a result of such decay would be bridged by the granular fill present above the deeper fill containing organics. To reduce the potential for bulging of the RAPs in the deeper fill containing organics, the RAPs should be grouted. This requirement may be waived based on the results of a modulus test performed in an area where the deeper fill contains organics.

The final design of RAPs should be performed by a professional engineer registered in the Commonwealth of Massachusetts and engaged by the contractor. A RAP load/modulus test would be required before the start of the production RAPs. The contractor should submit details about the RAP improvement program, including number, layout, size, and depth of the RAPs, and anticipated settlement of footings bearing on RAP improved ground at least two weeks before the start of the improvements. LGCI should be engaged to review the RAP submittal.

3.1.4 Footing Design

- The topsoil/subsoil layer and the existing fill are not suitable to support the proposed footings and should be entirely removed under footings.

- We recommend supporting the proposed buildings on spread and continuous footings bearing in the natural sand layer, on Structural Fill placed directly over the natural sand, or on RAP improved existing fill.

- For footing design, we recommend using a net allowable bearing pressure of 4,000 pounds per square foot (psf).

- The subgrade of footings should be prepared in accordance with the recommendations in Section 4.1

- All foundations should be designed in accordance with *The Commonwealth of Massachusetts State Building Code 780 CMR, Eighth Edition* (MSBC 8th Edition).

- Exterior footings and footings in unheated areas should be placed at a minimum depth of 4 feet below the final exterior grade to provide adequate frost cover protection. Interior footings in heated areas may be designed and constructed at a minimum depth of 2 feet below finished floor grades.

- We recommend that wall footings have a minimum width of 2 feet, and that column footings have a minimum width of 3 feet. For foundations with a least lateral dimension smaller than 3 feet, the allowable bearing pressure should be reduced to 1/3 of the recommended allowable bearing pressure times the least dimension in feet.

- Wall footings should be designed and constructed with continuous, longitudinal steel reinforcement for greater bending strength to span across small areas of loose or soft soils that may go undetected during construction.

- A representative of LGCI should observe the subgrade of footings to verify that the subgrade has been prepared in accordance with our recommendations.

3.1.5 Settlement

We estimate for foundations constructed in accordance with the recommendations contained in this report, that the total post-construction settlement will be less than about 1 inch and that the differential settlement will be 3/4 inch or less over a distance of 25 feet. Total and differential settlements of these magnitudes are usually considered tolerable for the anticipated construction. However, the tolerance of the proposed structure to the predicted total and differential settlements should be assessed by the structural engineer.

3.2 Concrete Slab Considerations

- The proposed floor slabs can be constructed as slabs-on-grade after the subgrade is prepared in accordance with recommendations in this Section and in Section 4.1.

- The existing fill should be entirely removed and replaced under the proposed slab on the western side of the proposed school building and under the proposed waste water treatment facility addition. The fill should be improved on the eastern side of the proposed school building and under the proposed half-time building. The existing fill should be improved in accordance with the recommendations in Section 4.1.

- We recommend supporting the proposed slab on a minimum of 12 inches of Structural Fill placed directly over the natural sand or on improved existing fill.

- The subgrade of the proposed slabs should be prepared in accordance with the recommendations in Section 4.1.

- A vapor retarder membrane with a minimum thickness of 15 mils could be used beneath the slabs. The need for such a membrane should be evaluated by the architect. The membrane should be protected from puncture during placement of the steel mesh and construction of the slabs.

- For the design of the floor slabs bearing on the materials described above, we recommend using a modulus of subgrade reaction, k_{s1}, of 100 tons per cubic foot (tcf) (116 pci). Please note that the values of k_{s1} are for a 1 x 1 square foot area. These values should be adjusted for larger areas using the following expression:

$$Modulus\ of\ Subgrade\ \mathrm{Re}action\,(k_s) = k_{s1} * \left(\frac{B+1}{2B}\right)^2$$

where:

k_s = Coefficient of vertical subgrade reaction for loaded area,
k_{s1} = Coefficient of vertical subgrade reaction for 1 x 1 square foot area, and
B = Width of area loaded, in feet.

Please note that cracking of slabs-on-grade can occur as a result of heaving or compression of the underlying soil, but also as a result of concrete curing stresses. To reduce the potential for cracking, the precautions listed below should be closely followed for construction of all slabs-on-grade:

- Construction joints should be provided between the floor slab and the walls and columns in accordance with the American Concrete Institute (ACI) requirements, or other applicable code.

- Backfill in interior and exterior utility trenches should be properly compacted as recommended in Section 3.7.

- In order for the movement of exterior slabs not to be transmitted to the building foundation or superstructure, exterior slabs such as approach slabs and sidewalks, should be isolated from the building superstructure.

3.3 Under-slab Drains

Based on the groundwater levels observed in our explorations and the location of the proposed buildings as conceived at the time of this report, an under-slab drainage system is not required

under the eastern side of the proposed school building, under the proposed half-time building, or under the proposed waste water treatment facility addition.

On the western side of the proposed school building, perched groundwater was observed in our explorations possibly caused by the presence of an impervious silty layer at the bottom of the existing fill. We understand that the design of the proposed school is proceeding with the "remove and replace" option. For this option, we anticipate that the Structural Fill placed to replace the unsuitable existing fill will be free draining; thus, causing the perched condition to cease to exist. Therefore, an under-slab drainage system is not required for the "remove and replace option." If the ground is improved with RAPs, the perched groundwater condition will continue to exist and an under-slab drainage system may be required. LGCI should be notified if such a change occurs so that we may amend our recommendation.

3.4 Seismic Design Criteria

In accordance with Section 1613 of MSBC 8th Edition, the seismic criteria for the site are as follows:

- Site Class: D
- Spectral Response Acceleration at short period (S_s): 0.24g
- Spectral Response Acceleration at 1 sec. (S_1): 0.060g
- Site Coefficient F_a (Table 9.4.1.2.4a): 1.6
- Site Coefficient F_v (Table 9.4.1.2.4b): 2.4
- Adjusted spectral response S_{ms}: 0.384g
- Adjusted spectral responses S_{m1}: 0.144g

Based on the existing deep groundwater table in the natural sand and the SPT N-values, and in accordance with Section 1806.4 of MSBC 8th Edition, the natural sand layer at the site is not susceptible to liquefaction during a seismic event.

3.5 Lateral Pressures for Wall Design and Perimeter Drains

3.5.1 Lateral Earth Pressures

We recommend using the following values for the design of retaining walls:

Coefficient of Active Earth Pressure, K_A:	0.31
Coefficient of At-Rest Earth Pressure, K_o:	0.5
Coefficient of Passive Earth Pressure, K_p:	3.3
Total Unit Weight, γ:	125 pounds per cubic foot

Note: The values in the table are based on a friction angle for the backfill of 32 degrees and neglecting friction between the backfill and the wall. The design active and passive coefficients are

based on horizontal surfaces (non-sloping backfill) on both the active and passive sides, and a vertical wall face.

- Site retaining walls should be designed using the active earth pressure coefficient shown above. Perimeter walls of below-ground spaces, if any, should be designed using the at-rest earth pressures.

- Passive earth pressures should only be used at the toe of the wall where special measures or provisions are taken to prevent disturbance or future removal of the soil on the passive side of the wall, or in areas where the wall design includes a key.

- Where a permanent vertical uniform load will be applied on the active side immediately adjacent to the wall, a horizontal surcharge load equal to half of the uniform vertical load should be applied over the height of the wall. At a minimum, a temporary construction surcharge of 100 psf should be applied uniformly over the height of the wall.

- We recommend using an ultimate friction factor of 0.50 between the natural sand and the bottom of the retaining wall. Retaining walls should be designed for minimum factors of safety of 1.5 for sliding and 2.0 for overturning.

3.5.2 Seismic Pressure

- In accordance with the *Massachusetts State Building Code, 8th Edition, Section 1610*, a lateral earthquake force equal to $0.100*(S_s)*(F_a)*\gamma*H^2$ should be included in the design of the wall (for horizontal backfill), where S_s is the maximum considered earthquake spectral response acceleration (defined in Section 3.4), F_a is the site coefficient (defined in Section 3.4), γ is the total unit weight of the soil backfill, and H is the height of the wall.

  The earthquake force should be distributed as an inverted triangle over the height of the wall. In accordance with MSBC 8th Edition, Section 1610.2, a load factor of 1.43 shall be applied to the earthquake force for wall strength design.

- Temporary surcharges should not be included when designing for earthquake loads. Surcharge loads applied for extended periods of time shall be included in the total static lateral soil pressure and their earthquake lateral force shall be computed and added to the force determined above.

3.5.3 Perimeter Drains

If the proposed school building includes an elevator, the elevator pit may require perimeter drains or should be designed as a waterproof box.

3.6 Parking Lots, Driveways, and Sidewalks

3.6.1 General

The subsurface conditions encountered at the site are generally suitable to support the proposed driveways and parking lots after preparation of the subgrade as described in Section 4.1.

- We recommend removing the surficial topsoil/subsoil within the footprint of the proposed paved areas.

- In existing fill areas, the ground should be improved by excavating at least one foot of the existing fill beneath the bottom of the proposed subbase and compacting the exposed subgrade as described in Section 4.1.

3.6.2 Sidewalks

- Sidewalks should be placed on a minimum of 12 inches of Structural Fill with less than 5 percent fines.

- To reduce the potential for heave caused by surface water penetrating under the sidewalk, the sidewalk concrete sections should be sealed with a waterproof compound. The sidewalks should be sloped away from the building or other vertical surfaces to promote flow of water. To the extent possible, roof leaders should not discharge onto sidewalk surfaces.

3.6.3 Typical Pavement Sections

A typical, minimum, standard-duty pavement section that could be used for parking areas is as follows:

1.5"	Asphalt "Top Course"
2.0"	Asphalt "Base Course"
8"	Processed Gravel for Sub-Base (MassDOT M1.03.1)

A typical, minimum, heavy-duty pavement section that could be used for areas of heavy truck traffic is as follows:

2.0"	Asphalt "Top Course"
2.5"	Asphalt "Base Course"
12"	Processed Gravel for Sub-Base (MassDOT M1.03.1)

The pavement sections shown above represent minimum thicknesses representative of typical local construction practices for similar use. Periodic maintenance should be anticipated.

Pavement material types and construction procedures should conform to specifications of the "Standard Specifications for Highways and Bridges," prepared by the Commonwealth of Massachusetts Department of Public Works and dated 1988 (with 2012 Supplemental Specifications).

Areas to receive relatively highly concentrated, sustained loads such as dumpsters, loading areas, and storage bins are typically installed over a rigid pavement section to distribute concentrated loads and reduce the possibility of high stress concentrations on the subgrade. Typical rigid pavement sections consist of 6 inches of concrete placed over a minimum of 12 inches of subbase material.

3.7 Underground Utilities

Existing fill containing organics encountered in utility trenches should be removed and replaced. Where the trenches terminate in the existing fill free of organics, the bottom of the trench should be improved as described in Section 4.1. To reduce the potential for the deep excavations associated with the removal of the unsuitable existing fill, we recommend installing and tying the utilities to the proposed school building on the eastern side of the site.

Utilities should be placed on suitable bedding material in accordance with the manufacturer's recommendations. "Cushion" material should be placed, by hand, above the utility pipe in maximum 6-inch lifts. The lift should be compacted by hand to avoid damage to the utility. Where the bedding/cushion material consists of crushed stone, it should be wrapped in a geotextile fabric.

Compaction of fill in utility trenches should be in accordance with our recommendations in Section 4.3. To reduce the potential for damage to utilities, placement and compaction of fill immediately above the utilities should be performed in accordance with the manufacturer's recommendations.

3.8 Sedimentation Basins

To help assess the drainage capacity of the soils within the possible locations of the proposed infiltration basins, we performed grain-size analyses on the materials excavated from depths of about 4 to 5 feet beneath the ground surface. The test results are summarized in Section 2.5.

LGCI used the Hazen Formula[1], an empirical relationship correlating the coefficient of permeability to the grain-size data.

The Hazen Formula correlates the coefficient of permeability to the diameter at 10 percent passing by weight also called effective size diameter, D_{10}, as follows:

$$K = C\,(D_{10})^2$$

Where C is a constant with an average value of 1, D_{10} is in mm (between 0.1 and 3 mm), and K is in cm/sec.

The results of the four (4) grain-size analyses from test pits TP-101, TP-107, TP-109, and TP-112 indicated D_{10} values of between about 0.25 and 0.32 mm, indicating a coefficient of permeability value between about 0.06 and 0.10 cm/sec. Soils with similar coefficient of permeability values are considered having good drainage.

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[1] Robert D. Holtz, and William D. Kovacs (1981), *An Introduction to Geotechnical Engineering*, Prentice Hall International, Inc., p.211.

4. CONSTRUCTION CONSIDERATIONS

4.1 Subgrade Preparation

- The topsoil/subsoil layer should be entirely removed from within the proposed building footprints and paved areas.

- For the "remove and replace" option, the existing fill should be entirely removed from within the western portion of the proposed school building and under the proposed waste water treatment facility addition. After the existing fill is removed, the exposed subgrade in the natural sand should be compacted using at last four (4) passes of a vibratory roller compactor imparting a dynamic effort of at least 40 kips.

- The existing fill should also be removed from under the proposed footings on the eastern side of the proposed school building and under the footings of the proposed half-time building.

- The existing fill removal should extend laterally beyond the limit of the proposed buildings a minimum distance equal to the distance between the bottom of the proposed footings and the natural sand or 5 feet, whichever is greater.

- The base of the footing excavations in the natural sand should be compacted with a dynamic vibratory compactor weighing at least 200 pounds and imparting a minimum of 4 kips of force to the subgrade, before placing the backfill or concrete.

- In areas with no existing fill, subgrades of slabs and paved areas in the natural sand should be compacted with a heavy vibratory roller compactor imparting a dynamic effort of at least 40 kips.

- To improve the fill under the proposed slab-on-grade on the eastern side of the proposed school building, under the proposed half-time building, and in paved areas, we recommend removing the top one foot of the existing fill and compacting the exposed subgrade with at least six (6) passes of a heavy vibratory roller compactor imparting a dynamic effort of at least 40 kips. Where soft zones are revealed by the compaction effort and where organic soil is exposed, the soft materials or organic soil should be removed and replaced with Structural Fill under buildings and with Ordinary Fill in paved areas. After the exposed subgrade is compacted, the removed existing fill that is free of organics can be placed back in 9-inch loose lifts up to the bottom of the proposed slab subbase or pavement subbase layer.

- At a minimum, 12 inches of Structural Fill should be placed under the proposed slab.

- Utility trenches in the existing fill free of organics, should be extended one foot deeper than the proposed trench bottom. The exposed subgrade should be compacted using at least 4

passes of a vibratory plate compactor imparting a minimum dynamic effort of 10 kips. After the exposed subgrade is compacted, the removed fill should be placed and compacted in six-inch lefts.

- Due to the high susceptibility of the natural sand for disturbance under foot and vehicular traffic, we recommend placing a minimum of 6 inches of Structural Fill under footings to provide a firm working surface during placement of formwork and rebar. If RAPs are used, we recommend placing at least 12 inches of Structural Fill between the bottom of the footings and the RAPs.

- Boulders at the bottom of excavations for footings and slabs should be removed, and the resulting excavation should be backfilled with compacted Structural Fill.

- Fill placed within the footprint of the proposed buildings should meet the gradation and compaction requirements of Structural Fill shown in Section 4.3.1.

- Fill placed under the subbase of paved areas, should meet the gradation and compaction requirements of Ordinary Fill shown in Section 4.3.2.

- Fill placed in the top 12 inches beneath sidewalks should consist of Structural Fill with less than 5 percent fines.

- When crushed stone is required in the drawings or it is used for the convenience of the contractor, it should be wrapped in a geotextile for separation.

- An LGCI geotechnical representative should observe the exposed subgrades prior to fill and concrete placement to verify that the exposed bearing materials are suitable for the design soil bearing pressure. If soft or loose pockets are encountered in the footing excavations, the soft or loose materials should be removed, and the bottom of the footing should be placed at a lower elevation on firm soil, or the resulting excavation should be backfilled with Structural Fill, or crushed stone wrapped in a filter fabric.

4.2 Subgrade Protection

The on-site sand may be frost susceptible. If construction takes place during freezing weather, special measures should be taken to prevent the subgrade from freezing. Such measures should include the use of heat blankets, or excavating the final six inches of soil just before pouring concrete. Footings should be backfilled as soon as possible after footing construction. Soil used as backfill should be free of frozen material, as should the ground on which it is placed. Filling operations should be halted in freezing weather.

Materials with high fine contents are typically difficult to handle when wet as they are sensitive to moisture content variations. Subgrade support capacities may deteriorate when such soils become wet and/or disturbed. The contractor should keep exposed subgrades properly drained and free of ponded water. Subgrades should be protected from machine and foot traffic to reduce disturbance.

4.3 Fill Materials

Structural Fill and Ordinary Fill should consist of inert, hard, durable sand and gravel, free from organic matter, clay, surface coatings and deleterious materials, and should conform to the gradation requirements shown below.

4.3.1 Structural Fill

The Structural Fill should have a plasticity index of less than 6, and should meet the gradation requirements shown below. Structural Fill should be compacted in maximum 9-inch loose lifts to at least 95 percent of the Modified Proctor maximum dry density (ASTM D1557), with moisture contents within ±2 percentage points of optimum moisture content.

Sieve Size	Percent Passing by Weight
3 inches	100
1 ½ inch	80 - 100
½ inch	50 – 100
No. 4	30 – 85
No. 20	15 – 60
No. 60	5 – 35
No. 200*	0 – 10

* 0 – 5 Under sidewalks

4.3.2 Ordinary Fill

Ordinary Fill should have a plasticity index of less than 6, and should meet the gradation requirements shown below. Ordinary Fill should be compacted in maximum 9-inch loose lifts to at least 95 percent of the Modified Proctor maximum dry density (ASTM D1557), with moisture contents within ±2 percentage points of optimum moisture content.

Sieve Size	Percent Passing by Weight
6 inches	100
1 inch	50 - 100
No. 4	20 – 100
No. 20	10 - 70

No. 60	5 – 45
No. 200	0 – 20

4.4 Reuse of Onsite Materials

Based on the grain-size analyses, the natural sand and the existing fill free of organics can be used as Structural Fill or Ordinary Fill.

Poorly graded soils generally require wetting during placement and compaction. The contractor should make available a watering truck to keep surfaces moist during earthwork operations.

During earthwork operations, the contractor should avoid mixing the reusable soils with fine-grained and/or organic soils. The soils to be reused should be excavated and stockpiled separately.

All materials to be used as fill should first be tested for compliance with the applicable gradation specifications.

4.5 Groundwater Control Procedures

Based on the groundwater levels encountered in our explorations, we do not anticipate that groundwater control procedures will be needed during building footing and utility excavations. We expect that filtered sump pumps installed in pits located at least three feet below the bottom of the excavation may be sufficient to handle the perched groundwater or surface runoff that may enter the excavation.

The contractor should be permitted to employ whatever commonly accepted means and practices as necessary to maintain the groundwater level below the bottom of the excavation, and to maintain a dry excavation during wet weather. Groundwater levels should be maintained at a minimum of 1-foot below the bottom of excavations during construction. Placement of reinforcing steel or concrete in standing water should not be permitted.

4.6 Temporary Excavations

All excavations to receive human traffic, including utility trenches, basement or footing excavations, or others (i.e. underground storage tanks, etc.), should be constructed in accordance with the OSHA guidelines.

The site soils should generally be considered Type “C” and should have a maximum allowable slope of 1.5 Horizontal to 1 Vertical (1.5H:1V) for excavations less than 20 feet deep. Deeper excavations, if needed, should have shoring designed by a professional engineer.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of the excavation sides and bottom.

5. RECOMMENDATIONS FOR FUTURE WORK

We recommend engaging LGCI to perform the following services:

- Review the geotechnical aspects of the contract drawings and provide comments in a letter.
- Review the geotechnical aspects of contractor submittals.
- Provide a field representative during construction to observe the subgrades for footings, floor slabs, ground improvements, if applicable, and paved areas, and to submit daily field reports documenting our observations and field recommendations.

6. REPORT LIMITATIONS

Our analysis and recommendations are based on project information provided to us at the time of this report. If changes to the type, size, and location of the proposed structures or to the site grading are made, the recommendations contained in this report shall not be considered valid unless the changes are reviewed and the conclusions and recommendations modified in writing by LGCI. LGCI cannot accept responsibility for designs based on our recommendations unless we are engaged to review the final plans and specifications to determine whether any changes in the project affect the validity of our recommendations and whether our recommendations have been properly implemented in the design.

It is not part of our scope to perform a more detailed site history; therefore, we have not explored for or researched the locations of buried utilities or other structures in the area of the proposed construction. Our scope did not include environmental services or services related to moisture, mold, or other biological contaminates in or around the site.

The recommendations in this report are based in part on the data obtained from the subsurface explorations. The nature and extent of variations between explorations may not become evident until construction. If variations from anticipated conditions are encountered, it may be necessary to revise the recommendations in this report. We cannot accept responsibility for designs based on recommendations in this report unless we are engaged to 1) make site visits during construction to check that the subsurface conditions exposed during construction are in general conformance with our design assumptions and 2) ascertain that, in general, the work is being performed in compliance with the contract documents.

Our report has been prepared in accordance with generally accepted engineering practices and in accordance with the terms and conditions set forth in our agreement. No other warranty, expressed or implied, is made. This report has been prepared for the exclusive use of Ai3 Architects LLC for the specific application to the proposed Plymouth South High School in Plymouth, Massachusetts as conceived at this time.

7. REFERENCES

The Commonwealth of Massachusetts (2010), "The Massachusetts State Building Code, 780 CMR, Eighth Edition."

The Department of Labor, Occupational Safety and Health Administration (1989), "Occupational Safety and Health Standards - Excavations; Final Rule," 20 CFR Part 1926, Subpart P.

USGS Plymouth, MA topographic map from www.digital-topo-maps.com

Table 1 - Summary of Test Pits
Proposed Plymouth South School
Plymouth, Massachusetts
LGCI Project No. 1408

Test Pit No.	Ground Surface Elevation (ft.)*	Groundwater** Depth / El. (ft.)	Bottom of Topsoil Depth / El. (ft.)	Bottom of Fill *** Depth / El. (ft.)	Bottom of Test Pit Depth / El. (ft.)
TP-1	211.5	6 / **205.5**	1.5 / **210**	13.5 / **198**	13.5 / **198**
TP-2	214.5	4 / **210.5**	0.9 / **213.6**	9.5 / **205**	12 / **202.5**
TP-3	215.5	3 / **212.5**	1 / **214.5**	7.5 / **208**	11 / **204.5**
TP-4	214.5	- / -	1.1 / **213.4**	4 / **210.5**	11 / **203.5**
TP-5	213.5	- / -	0.7 / **212.8**	4 / **209.5**	10.5 / **203**
TP-6	214	2.5 / **211.5**	0.9 / **213.1**	6.5 / **207.5**	12 / **202**
TP-7	215	- / -	1 / **214**	6.5 / **208.5**	11 / **204**
TP-8	215	6 / **209**	0.8 / **214.2**	12 / **203**	12 / **203**
TP-9	216	2.5 / **213.5**	0.8 / **215.2**	8 / **208**	12 / **204**
TP-10	216.5	- / -	1.1 / **215.4**	- / **-**	10 / **206.5**
TP-11	214.5	- / -	0.9 / **213.6**	- / **-**	11 / **203.5**
TP-12	233	- / -	1.3 / **231.7**	- / **-**	11 / **222**
TP-101	212.5	8 / **204.5**	1 / **211.5**	10.5 / **202**	11.5 / **201**
TP-102	213	6 / **207**	1 / **212**	10 / **203**	10.5 / **202.5**
TP-103	213.5	3.5 / **210**	0.8 / **212.7**	5.5 / **208**	11 / **202.5**
TP-104	213.5	NA / -	0.8 / **212.7**	3.4 / **210.1**	10.5 / **203**
TP-105	204.5	NA / -	0.5 / **204**	2 / **202.5**	11 / **193.5**
TP-106	209.5	NA / **-**	0.3 / **209.2**	3.5 / **206**	10 / **199.5**
TP-107	209.5	NA / -	0.7 / **208.8**	3 / **206.5**	10 / **199.5**
TP-108	210.5	NA / **0**	1.3 / **209.2**	1.8 / **208.7**	11 / **199.5**
TP-109	209.5	NA / **-**	1 / **208.5**	4 / **205.5**	10 / **199.5**
TP-110	206.5	NA / -	0.7 / **205.8**	10 / **196.5**	11 / **195.5**
TP-111	210	NA / -	0.6 / **209.4**	5 / **205**	10.5 / **199.5**
TP-112	214	NA / -	0.9 / **213.1**	2 / **212**	10 / **204**

* Ground surface elevations for TP-1 to TP-12 interpolated from Survey Plan prepared by CHA and dated 01/29/14.

* Ground surface elevations for TP-101 to TP-111 were interpolated from Plan titled: "Overall Site Plan," prepared by Ai3 Architect / Pare Corporation and dated July 2014.

* The elevations are approximate.

* Ground surface elevation are referenced with respect to NAVD 88.

** Groundwater in the test pits may be due perched groundwater condition.

*** TP-1 and TP-8 terminated in the fill.

Table 2 - Summary of Borings
Proposed Plymouth South High School
Plymouth, Massachusetts
LGCI Project No. 1408

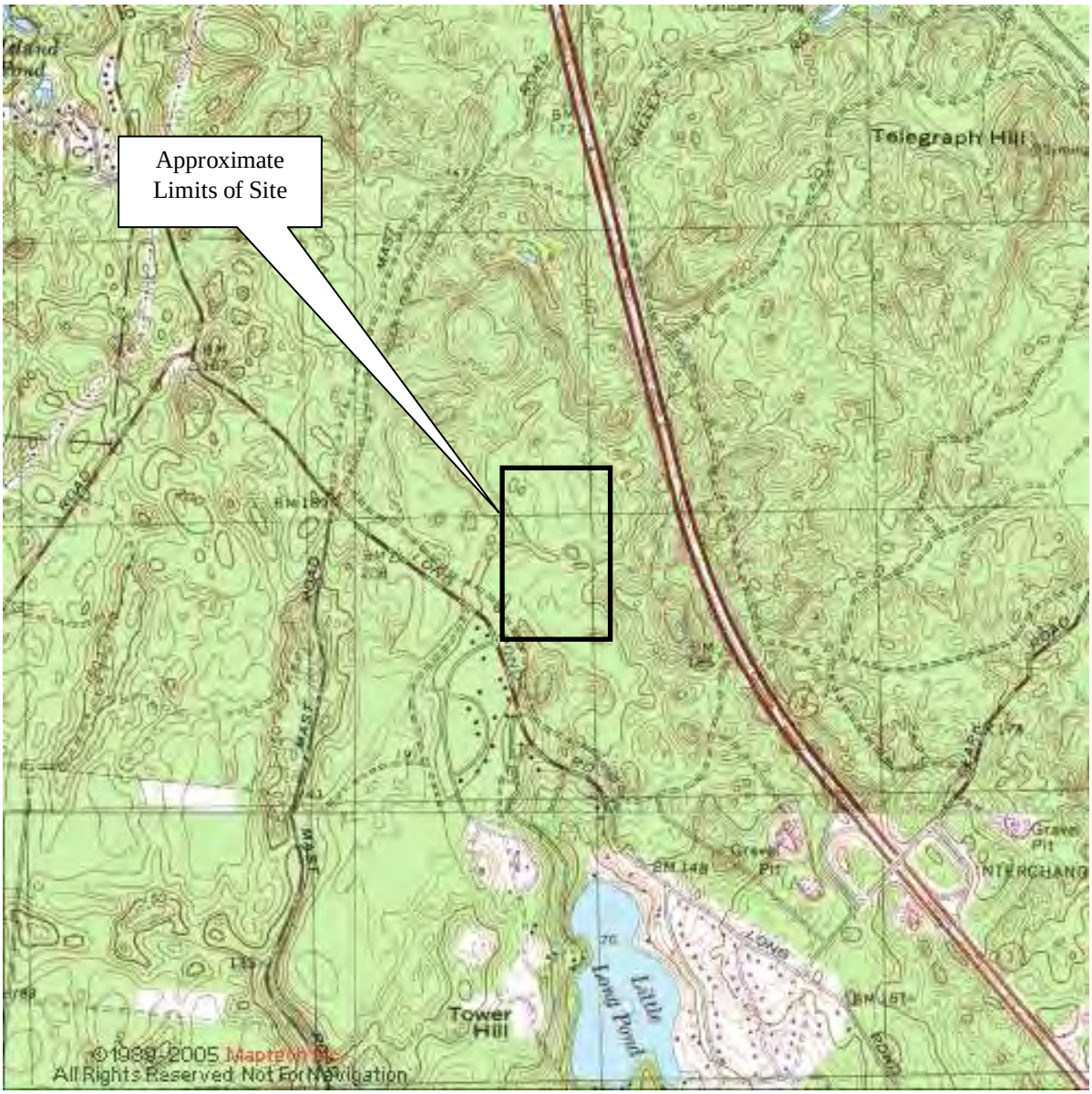
Boring No.	Ground Surface Elevation (ft.)*	Groundwater Depth / El. (ft.)*	Bottom of Topsoil Depth / El. (ft.)*	Bottom of Fill Depth / El. (ft.)	Bottom of Boring Depth / El. (ft.)*
B-1	213.5	10 / **203.5**	1.2 / **212.3**	15 / **198.5**	42 / **171.5**
B-2	214	2 / **212**	1 / **213**	12 / **202**	42 / **172**
B-3	216	- / -	1.2 / **214.8**	4 / **212**	66 / **150**
B-4	213	- / -	0.6 / **212.4**	5 / **208**	42 / **171**
B-5	214	- / -	1 / **213**	7 / **207**	42 / **172**
B-101	213	4.8 / **208.2**	0.7 / **212.3**	10.9 / **202.1**	17 / **196**
B-102	214	32 / 182	0.9 / **213.1**	7 / **207**	36 / **178**
B-103	214.5	4 / 210.5	0.9 / **213.6**	10.4 / **204.1**	35 / **179.5**
B-104	215.5	3 / 212.5	1 / **214.5**	7 / **208.5**	21 / **194.5**
B-105	215	5 / **210**	0.7 / **214.3**	8.5 / **206.5**	21 / **194**
B-106	216	NA / -	1 / **215**	5.4 / **210.6**	17 / **199**
B-107	215.5	NA / -	0.8 / **214.7**	5.8 / **209.7**	17 / **198.5**
B-108	214.5	NA / -	0.6 / **213.9**	5.1 / **209.4**	17 / **197.5**
B-109	213.5	NA / **-**	0.5 / **213**	2.2 / **211.3**	17 / **196.5**
B-110	214.5	NA / -	1 / **213.5**	6 / **208.5**	17 / **197.5**
B-111	210	NA / -	NA / **-**	1 / **209**	17 / **193**
B-112	216	5 / 211	1.2 / **214.8**	13.3 / **202.7**	17 / **199**
B-113	217	NA / **-**	0.3 / **216.7**	4 / **213**	11 / **206**
B-114	211	NA / -	NA / **-**	0.9 / **210.1**	22 / **189**
B-115	NOT PERFORMED	/	/	/	/
B-116	214	NA / -	1 / **213**	11 / **203**	17 / **197**
B-117	214	NA / **-**	1.1 / **212.9**	7.8 / **206.2**	22 / **192**

* Ground surface elevations for B-1 to B-5 were interpolated from Survey Plan prepared by CHA and dated 01/29/14.

* Ground surface elevations for B-101 to B-117 were interpolated from Plan titled: "Overall Site Plan," prepared by Ai3 Architect / Pare Corporation and dated July 2014.

* The elevations are approximate.

* Ground surface elevation are referenced with respect to NAVD 88.

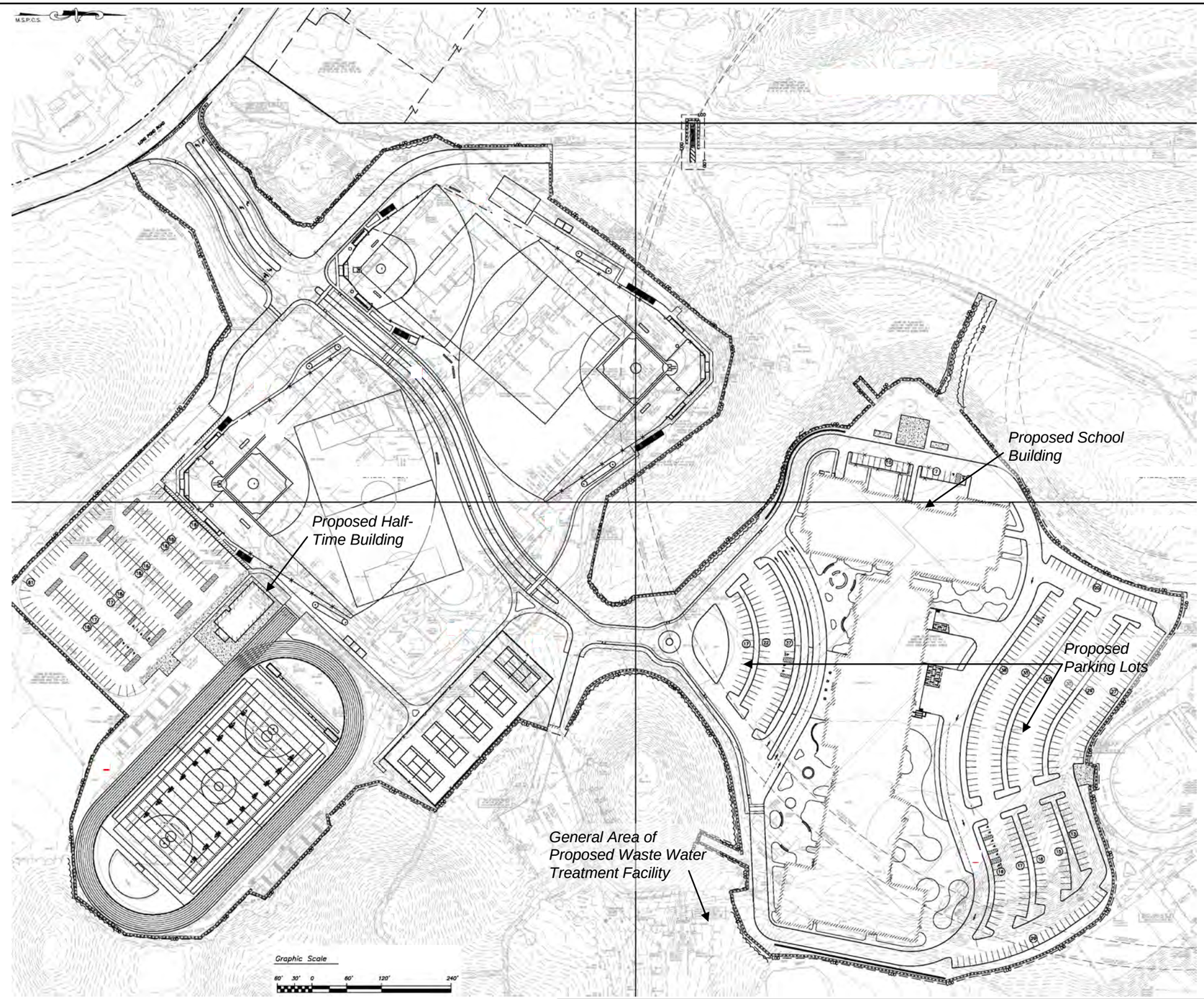


N

Approximate Scale: 1:25000
Contour intervals: 10 feet

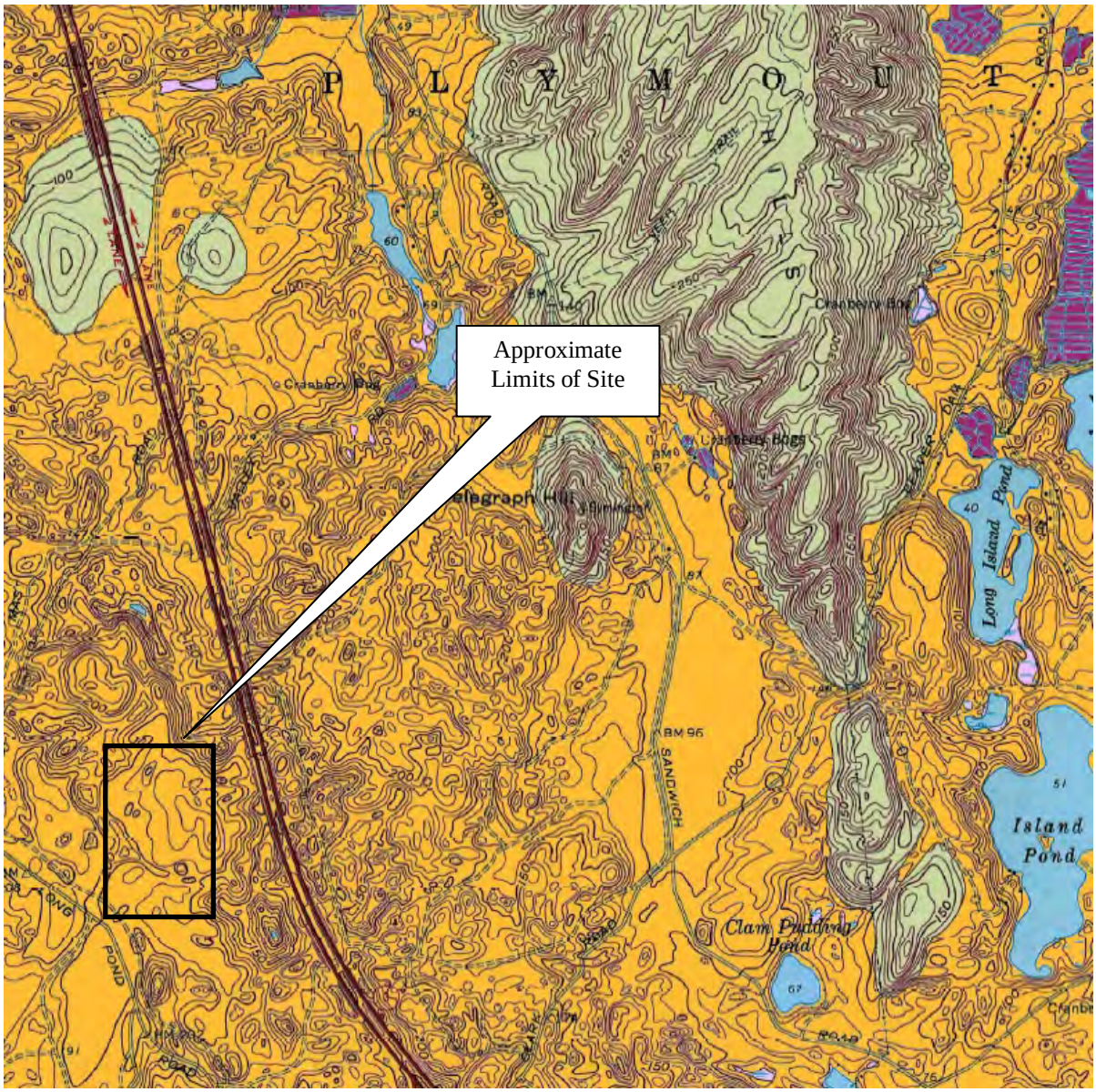
Note: Figure based on USGS topographic map of Plymouth, MA – from http://mapserver.mytopo.com

Client:	Project:		
Ai3 Architects LLC	Proposed Plymouth South High School	**Figure 1 – Site Location Map**	
LGCI Lahlaf Geotechnical Consulting, Inc.	Project Location: Plymouth, MA	LGCI Project No.: 1408	Date: Sept. 2014



Note – Figure based plan titled "Overall Site Plan," prepared by Pare Corporation and dated July 2014.

Client:	Project:	Figure 2 – Proposed Construction Layout	
Ai3 Architects LLC	Proposed Plymouth South High School		
LGCI Lahlaf Geotechnical Consulting, Inc.	Project Location	LGCI Project No.	Date:
	Plymouth, MA	1408	Sept. 2014



GLACIAL STRATIFIED DEPOSITS

Coarse deposits include gravel deposits composed of at least 50 percent gravel-size clasts; cobbles and boulders predominate; minor amounts of sand occur within gravel beds, and sand comprises few separate layers. Gravel layers generally are poorly sorted, and bedding commonly is distorted and faulted due to postdepositional collapse related to melting of ice. Sand and gravel deposits occur as mixtures of gravel and sand within individual layers and as layers of sand alternating with layers of gravel. Sand and gravel layers generally range from 25 to 50 percent gravel particles and from 50 to 75 percent sand particles. Layers are well to poorly sorted; bedding may be distorted and faulted due to postdepositional collapse. Sand deposits are composed mainly of very coarse to fine sand, commonly in well-sorted layers. Coarser layers may contain up to 25 percent gravel particles, generally granules and pebbles; finer layers may contain some very fine sand, silt, and clay

Note: Figure based on "Surficial geologic map of the Norton-Manomet-Westport-Sconticut Neck 23-quadrangle area in southeast Massachusetts," prepared by Stone, B.D., Stone, J.R., DiGiacomo-Cohen, M.L., and Kincare, K.A., for U.S. Geological Survey, 2011, Open-File Report 2006–1260–F.

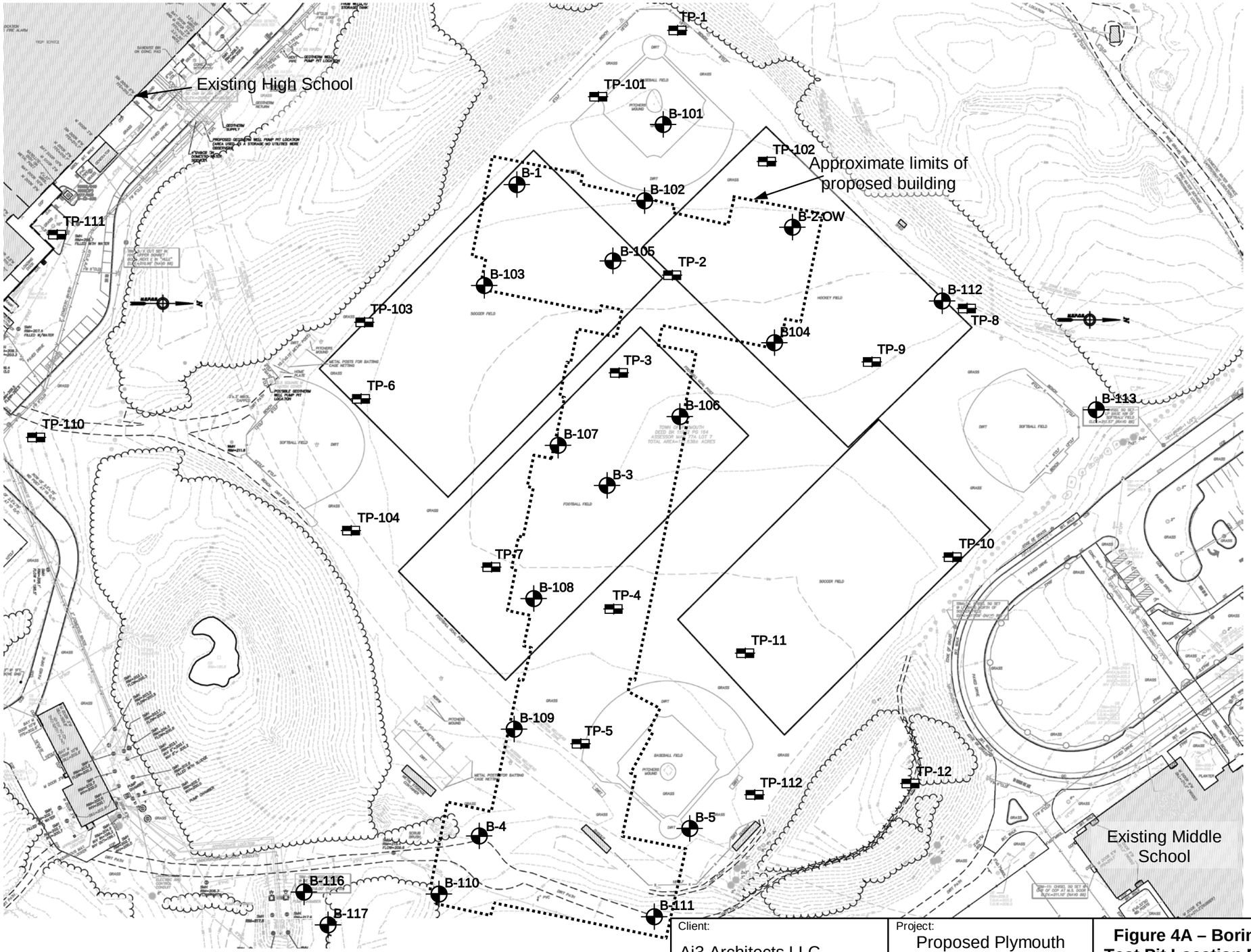
Client:	Project:	**Figure 3 – Surficial Geologic Map**	
Ai3 Architects LCC	Proposed Plymouth South High School		
LGCI Lahlaf Geotechnical Consulting, Inc.	Project Location: Plymouth, MA	LGCI Project No.: 1408	Date: Sept. 2014

Note – Figure based on a survey plan provided to us by Pare Corporation (Pare) on April 22, 2014 and on a Plan titled "Overall Site Plan," prepared by Pare and dated July 2014.

Legend

Approximate location of boring. Borings B-1 to B-5 advanced by Northern Drill Service of Northborough, MA between April 5 and 7, 2014. Borings B-101 to B-117 advanced by New Hampshire Boring of Brockton, MA between August 13 and 18, 2014. All borings were observed by Lahlaf Geotechnical Consulting, Inc. (LGCI).
OW denotes that a groundwater observation well was installed in the borehole.

Approximate location of test pit excavated by J. C. Engineering, Inc. of East Wareham, MA. TP-1 to TP-12 excavated on April 3 and 4, 2014. TP-101 to TP-112 excavated on August 11 and 12, 2014. All test pits were



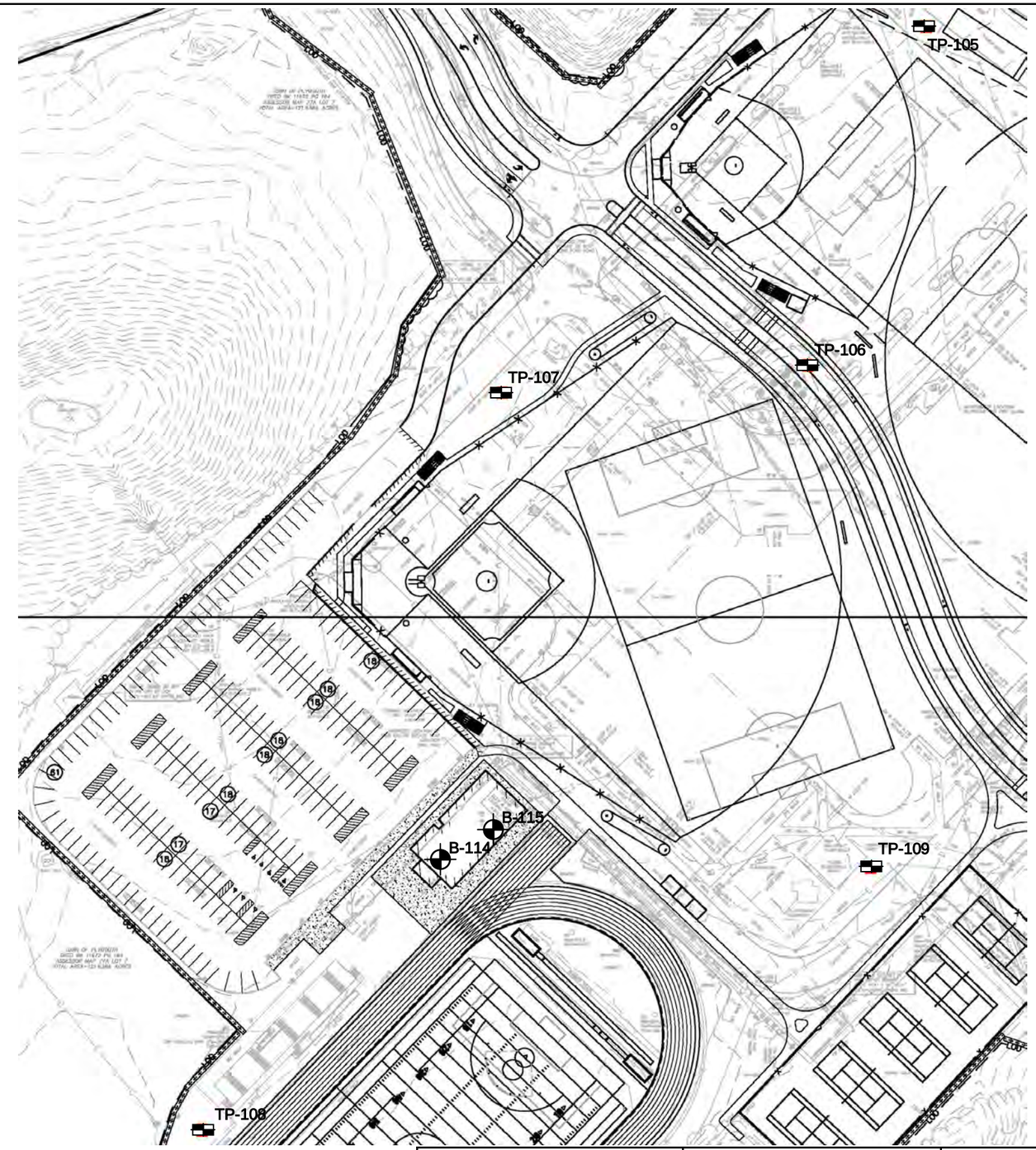
Client:	Project:	Figure 4A – Boring and Test Pit Location Plan 1/2	
Ai3 Architects LLC	Proposed Plymouth South High School		
LGCI Lahlaf Geotechnical Consulting, Inc.	Project Location: Plymouth, MA	LGCI Project No.: 1408	Date: Sept. 2014

Note – Figure based plan titled "Overall Site Plan," prepared by Pare Corporation and dated July 2014.

Legend

Approximate location of boring advanced by New Hampshire Boring of Brockton, MA between August 13 and 18, 2014 and observed by Lahlaf Geotechnical Consulting, Inc. (LGCI). Boring B-115 was not advanced due to proximity to utilities.

Approximate location of test pit excavated by J. C. Engineering, Inc. of East Wareham, MA on August 11 and 12, 2014 and observed by LGCI.



APPROXIMATE SCALE (ft.)

60' 30' 0 60' 120' 240'

Client: Ai3 Architects LLC	Project: Proposed Plymouth South High School	Figure 4B – Boring and Test Pit Location Plan 2/2	
LGCI Lahlaf Geotechnical Consulting, Inc.	Project Location Plymouth, MA	LGCI Project No. 1408	Date: Sept. 2014

Appendix A Test Pit Logs

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	04/04/14
Excavation Foreman : Tim Lydon		Date Completed:	04/04/14
LGCI Engineer:	Geetha Mathiyalakan	Location:	Western corner of existing Athletic fields
Ground Surface El:	Est. 211.5 ft (see remark 1)	Total Depth:	13.5 feet
Groundwater Depth:	Seeped at 6 ft (perched groundwater)	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	4.5' x 10'

Depth Scale	Exc. Effort	Strata	Soil Description
	E	Topsoil/ Subsoil ~1.6'	7": Topsoil 7" - 19": Silty SAND (SM), fine to medium, 10-15% fines, ~5% cobbles, traces of organics, thin (~4") layer of mostly organics near the bottom, brown, moist (subsoil)
	E - M	Fill	19" - 3.3': Poorly Graded SAND with Silt (SP-SM), fine to medium, ~10% fines, brown-tan, moist (fill)
	E - M		
	E - M		3.3' - 4' : thin (~8") layer of buried topsoil
5 ft	E - M		4' - 7.7': Poorly Graded SAND with Silt (SP-SM), mostly fine, ~10% fines, occasional thin (~2") layers of organics, tan-brown, moist to wet (fill)
	E - M		
	E - M		
	E - M		
	M		7.7' - 12': Silty SAND (SM), fine to medium, ~20% fines, 5-10% cobbles, traces of organics, 10-15% roots, one tree stump up to 2 feet long and about 12 inches in diameter at 11 feet, dark gray, moist (fill)
10 ft	M		
	M		
	M		12' - 13.5': Silty SAND (SM), fine to medium, ~20% fines, traces of organics, 5-10% roots, dark gray, moist (fill)
	M		
	M		Bottom of test pit at 13.5 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1. The elevation was interpolated from plan titled " Plymouth South HS Survey," by CHA Consulting, Inc., dated 1/29/14, and is approximate.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	04/04/14
Excavation Foreman : Tim Lydon		Date Completed:	04/04/14
LGCI Engineer:	Geetha Mathiyalakan	Location:	Western side of proposed building
Ground Surface El:	Est. 214.5 ft (see remark 1)	Total Depth:	12 feet
Groundwater Depth:	Seeped at 4 ft	Excavator Type:	KUBOTA KX080-3
	(perched groundwater)	Test Pit Dimensions:	3' to 11' x 15' (see remark 2)

Depth Scale	Exc. Effort	Strata	Soil Description
	E	**Topsoil/ Subsoil**	6": Topsoil 6" - 11": Silty SAND (SM), fine to medium, 10-15% fines, traces of roots, brown, moist (subsoil)
	E - M	**Fill**	11" - 5.5': Poorly Graded SAND with Silt (SP-SM), fine to medium, ~10% fines, ~5% gravel, ~5% cobbles, brown with occasional thin (~2") dark brown seams, moist to wet (fill)
	E - M		
	E - M		
5 ft	M		
	D		5.5' to 9.5': Cluster of four boulders up to 4.5 ft mixed in with Silty SAND (SM), fine to medium, ~15% fines, traces of organics, ~10% roots, two tree stumps up to 2 feet long and about 6 inches in diameter, dark gray, moist (fill)
	D		
	D		
	D		
		~9.5'	
10 ft	D	**Sand**	9.5' - 12': Poorly Graded SAND (SP), fine to medium, 5-10% fines, 5-10% gravel, light tan, moist
	M		
	M		
			Bottom of test pit at 12 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate compactor.
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1. The elevation was interpolated from plan titled " Plymouth South HS Survey," by CHA Consulting, Inc., dated 1/29/14, and is approximate.
2 - Unstable sides in the top 6 feet. The test pit opened up to 11 feet wide after excavating the boulders.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	04/04/14
Excavation Foreman : Tim Lydon		Date Completed:	04/04/14
LGCI Engineer:	Geetha Mathiyalakan	Location:	Western side of proposed building
Ground Surface El:	Est. 215.5 ft (see remark 1)	Total Depth:	11 feet
Groundwater Depth:	Seeped at 3 ft (perched groundwater)	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	3' x 11'

Depth Scale	Exc. Effort	Strata	Soil Description
	E	Topsoil/ Subsoil	6": Topsoil 6" - 12": Silty SAND (SM), fine to medium, ~15% fines, traces of roots, brown, moist (subsoil)
	E - M	Fill	12" - 4': Poorly Graded SAND with Silt and Gravel (SP-SM), fine to medium, 10-15% fines, 15-20% gravel, brown with occasional thin (~2") bright brown seams, moist to wet (fill)
	E - M		
	E - M		
5 ft	M		4' to 7.5': Silty SAND (SM), mostly fine, 20-25% fines, traces of organics, traces of roots, ~5% cobbles, dark gray, moist (fill)
	M		
	M		
	M	~7.5'	
	M	Sand	7.5' - 11': Poorly Graded SAND (SP), fine to medium, ~5% fines, ~5% gravel, light tan, moist
	M		
10 ft	M		
	M		
			Bottom of test pit at 11 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate compactor.
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1. The elevation was interpolated from plan titled " Plymouth South HS Survey," by CHA Consulting, Inc., dated 1/29/14, and is approximate.
2 - Unstable sides in the top 4 feet due to seeping perched groundwater.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	04/03/14
Excavation Foreman : Tim Lydon		Date Completed:	04/03/14
LGCI Engineer:	Geetha Mathiyalakan	Location:	Near center of proposed building
Ground Surface El:	Est. 214.5 ft (see remark 1)	Total Depth:	11 feet
Groundwater Depth:	Not encountered	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	3' to 6 ' x 9' (see remark 2)

Depth Scale	Exc. Effort	Strata	Soil Description
	E	Topsoil/ Subsoil	5": Topsoil 5" - 13": Silty SAND (SM), fine to medium, 10-15% fines, brown, moist (subsoil)
	E - M	Fill	13" - 4': Poorly Graded SAND (SP), mostly medium, ~5% fines, tan-brown with occasional thin (~2") dark brown seams, moist (fill)
	E - M		
	E - M	~4'	
5 ft	E - M	Sand	4' to 7': Poorly Graded SAND (SP), fine to medium, 5-10% fines, 5-10% fine gravel, tan, moist
	E - M		
	E - M		
	M		7' - 11': Poorly Graded SAND (SP), mostly medium to coarse, 5-10% fines, 5-10% gravel, a few cobbles near the bottom, light tan, moist
	M		
10 ft	M		
	M		
			Bottom of test pit at 11 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate compactor.
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1. The elevation was interpolated from plan titled " Plymouth South HS Survey," by CHA Consulting, Inc., dated 1/29/14, and is approximate.

2 - Unstable sides in the top 7 feet. The excavation opened up to about 6 feet wide.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	04/03/14
Excavation Foreman : Tim Lydon		Date Completed:	04/03/14
LGCI Engineer:	Geetha Mathiyalakan	Location:	Eastern side of proposed building
Ground Surface El:	Est. 213.5 ft (see remark 1)	Total Depth:	10.5 feet
Groundwater Depth:	Not encountered	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	3' to 5' x 9' (see remark 2)

Depth Scale	Exc. Effort	Strata	Soil Description
	E	**Topsoil/ Subsoil**	6": Topsoil 6" - 8": Silty SAND (SM), fine to medium, ~10-15% fines, brown, moist (subsoil)
	E - M E - M E - M	**Fill** ~4'	8" - 4': Well Graded SAND with Gravel (SW), mostly medium, 15-20% fine gravel, tan-brown with occasional thin (~2") dark brown seams, moist (fill)
5 ft	E - M E - M E - M E - M	**Sand**	4' to 8': Poorly Graded SAND (SP), mostly medium, ~5% fines, 5-10% fine gravel, dark tan, moist
10 ft	E - M E - M E - M		8' - 10.5': Poorly Graded SAND (SP), mostly medium to coarse, ~5% fines, 5-10% gravel, light tan, moist
15 ft	E - M		Bottom of test pit at 10.5 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1. The elevation was interpolated from plan titled " Plymouth South HS Survey," by CHA Consulting, Inc., dated 1/29/14, and is approximate.
2 - Unstable sides in the top 5 feet. The excavation opened up to about 5 feet wide.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	04/03/14
Excavation Foreman : Tim Lydon		Date Completed:	04/03/14
LGCI Engineer:	Geetha Mathiyalakan	Location:	Southern side of existing athletic fields
Ground Surface El:	Est. 214 ft (see remark 1)	Total Depth:	12 feet
Groundwater Depth:	Seeped at 2.5 ft (perched groundwater)	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	3' x 10'

Depth Scale	Exc. Effort	Strata	Soil Description
	E	Topsoil/ Subsoil	7": Topsoil 7" -11": Silty SAND (SM), fine to medium, ~10-15% fines, brown, moist (subsoil)
	E - M	Fill	11" - 2.5': Poorly Graded SAND (SP), fine to medium, ~10% fines, bright brown with occasional thin (~1") reddish brown seams, moist to wet (fill)
	E - M		
	M		2.5' to 6.5': Silty SAND (SM), mostly fine, 25-30% fines, 5-10% cobbles, traces of organics, ~10% roots, dark gray, moist (fill)
5 ft	M		
	M		
	M	~6.5'	
	M	Sand	6.5' - 12': Poorly Graded SAND (SP), mostly medium, 5-10% fines, 5-10% gravel, tan, moist
	M		
	M		
10 ft	M		
	M		
	M		
			Bottom of test pit at 12 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate compactor.
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1. The elevation was interpolated from plan titled " Plymouth South HS Survey," by CHA Consulting, Inc., dated 1/29/14, and is approximate.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	04/03/14
Excavation Foreman : Tim Lydon		Date Completed:	04/03/14
LGCI Engineer:	Geetha Mathiyalakan	Location:	Near southern side of prop. building
Ground Surface El:	Est. 215 ft (see remark 1)	Total Depth:	11 feet
Groundwater Depth:	Not encountered	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	3' to 6' x 9' (see remark 2)

Depth Scale	Exc. Effort	Strata	Soil Description
	E	Topsoil/ Subsoil	6": Topsoil 6" -12": Silty SAND (SM), fine to medium, ~10-15% fines, traces of organics, brown, moist (subsoil)
	E - M	Fill	12" - 4': Poorly Graded SAND (SP), fine to medium, ~ 5% fine gravel. brown-tan, moist (fill)
	E - M		
	E - M		4' - 4.3': thin (~4") layer of mostly gravel, traces of cobbles (fill)
5 ft	E - M		4.3' to 6': Poorly Graded SAND (SP), mostly medium to coarse, ~5% fines, 5-10% gravel, tan, moist (fill)
	E - M		
		~6.5'	6' - 6.5': thin (~6") layer of mostly gravel, <5% cobbles (fill)
	E - M	Sand	6.5' - 12': Poorly Graded SAND (SP), fine to medium, ~5% fines, ~5% gravel, <5% cobbles, tan, moist
	E - M		
	E - M		
10 ft	E - M		
	E - M		
			Bottom of test pit at 11 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate compactor.
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1. The elevation was interpolated from plan titled " Plymouth South HS Survey," by CHA Consulting, Inc., dated 1/29/14, and is approximate.

2 - Unstable sides in the top 6 feet. The excavation opened up to about 6 feet wide.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	04/03/14
Excavation Foreman : Tim Lydon		Date Completed:	04/03/14
LGCI Engineer:	Geetha Mathiyalakan	Location:	Northern corner of existing athletic fields
Ground Surface El:	Est. 215 ft (see remark 1)	Total Depth:	12 feet
Groundwater Depth:	Seeped at 6 ft (perched groundwater)	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	3' x 11'

Depth Scale	Exc. Effort	Strata	Soil Description
	E	Topsoil/ Subsoil	6": Topsoil 6" - 10": Silty SAND (SM), fine to medium, 10-15% fines, brown, moist (subsoil)
	E - M	Fill	10" - 2.5': Silty SAND with Gravel (SM), fine to medium, 10-15% fines, 15-20% gravel, brown, moist (fill)
	E - M		2.5' - 6.5': Poorly Graded SAND (SP), mostly medium, 5-10% fines, bright brown, moist (fill)
	E - M		
5 ft	E - M		
	E - M		
	E - M		
	M		6.5' - 9': Silty SAND (SM) fine to medium, ~20% fines, ~10% gravel, ~5% cobbles, traces of organics, 5-10% roots, gray, moist (fill)
	M		
10 ft	M		9' - 12': Silty SAND (SM), mostly fine, ~20% fines, traces of organics, ~25% roots, dark gray, most (fill)
	M		
	M		
			Bottom of test pit at 12 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate compactor.
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1. The elevation was interpolated from plan titled " Plymouth South HS Survey," by CHA Consulting, Inc., dated 1/29/14, and is approximate.
2 - Unstable sides in the top 6 feet due to seeping of perched groundwater.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	04/03/14
Excavation Foreman : Tim Lydon		Date Completed:	04/03/14
LGCI Engineer:	Geetha Mathiyalakan	Location:	Northern side of existing athletic fields
Ground Surface El:	Est. 216 ft (see remark 1)	Total Depth:	12 feet
Groundwater Depth:	Seeped at 2.5 ft (perched groundwater)	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	3' x 10'

Depth Scale	Exc. Effort	Strata	Soil Description
	E	**Topsoil/ Subsoil**	6": Topsoil 6" - 10": Silty SAND (SM), mostly fine, 10-15% fines, brown, moist (subsoil)
	E - M	**Fill**	10" - 4': Poorly Graded SAND (SP), fine to medium, ~10% fines, brown, moist to wet (fill)
	E - M		
	E - M		
5 ft	M		4' - 8': Silty SAND (SM), fine to medium, ~25% fines, ~5% cobbles, traces of organics, ~10% roots, dark gray, moist (fill)
	M		
	M		
	M	~8'	
	M	**Sand**	8' - 12': Poorly Graded SAND (SP), mostly medium to coarse, ~5% fines, 5-10% gravel, tan, moist
10 ft	M		
	M		
	M		
			Bottom of test pit at 12 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1. The elevation was interpolated from plan titled " Plymouth South HS Survey," by CHA Consulting, Inc., dated 1/29/14, and is approximate.

2 - Unstable sides in the top 4 feet due to seeping of perched groundwater.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	04/04/14
Excavation Foreman : Tim Lydon		Date Completed:	04/04/14
LGCI Engineer:	Geetha Mathiyalakan	Location:	Northern side of existing athletic fields
Ground Surface El:	Est. 216.5 ft (see remark 1)	Total Depth:	10 feet
Groundwater Depth:	Not encountered	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	3' to 8 ' x 10' (see remark 2)

Depth Scale	Exc. Effort	Strata	Soil Description
	E	**Topsoil/ Subsoil**	6": Topsoil 6" - 13": Silty SAND (SM), fine, traces of gravel, ~15% fines, traces of roots, brown, moist (subsoil)
	E - M	**Sand**	13" - 10': Poorly Graded SAND (SP), mostly medium, 5-10% coarse, occasional thin (~3") layers of coarse, ~5% fines, 5-10% gravel, <5% cobbles, light tan, moist
	E - M		
	E - M		
5 ft	M		
	M		
	M		
	M		
	M		
10 ft	M		
			Bottom of test pit at 10 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate compactor.
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1. The elevation was interpolated from plan titled " Plymouth South HS Survey," by CHA Consulting, Inc., dated 1/29/14, and is approximate.
2 - Excavation opened wider to 8 feet and continued to collapse when attempted to excavate deeper than 10 feet.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	04/04/14
Excavation Foreman : Tim Lydon		Date Completed:	04/04/14
LGCI Engineer:	Geetha Mathiyalakan	Location:	Northern side of existing athletic fields
Ground Surface El:	Est. 214.5 ft (see remark 1)	Total Depth:	11 feet
Groundwater Depth:	Not encountered	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	3' to 5 ' x 10'

Depth Scale	Exc. Effort	Strata	Soil Description
	E	**Topsoil/ Subsoil**	5": Topsoil 5" - 11": Silty SAND (SM), fine, traces of fine gravel, 10-15% fines, traces of roots, brown, moist (subsoil)
	E - M	**Sand**	11" - 6': Poorly Graded SAND (SP), fine to medium, <5% fines, 5-10% gravel, light tan, moist
	E - M		
	E - M		
5 ft	E - M		
	E - M		
	E - M		6' - 11': Poorly Graded SAND (SP), medium to coarse, <5% fines, ~10% gravel, <5% cobbles, light tan, moist
	E - M		
	E - M		
10 ft	E - M		
	E - M		
			Bottom of test pit at 11 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate compactor.
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1. The elevation was interpolated from plan titled " Plymouth South HS Survey," by CHA Consulting, Inc., dated 1/29/14, and is approximate.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	04/03/14
Excavation Foreman : Tim Lydon		Date Completed:	04/03/14
LGCI Engineer:	Geetha Mathiyalakan	Location:	Hill near NE side of exist. athletic fields
Ground Surface El:	Est. 233 ft (see remark 1)	Total Depth:	11 feet
Groundwater Depth:	Not encountered	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	3' to 6 ' x 10'

Depth Scale	Exc. Effort	Strata	Soil Description
	E	**Topsoil/ Subsoil** ~1.3'	8": Topsoil 8" - 16": Silty SAND (SM), fine, 10-15% fines, traces of roots, bright brown, moist (subsoil)
	E - M	**Sand**	16" - 3': Poorly Graded SAND with Silt (SP-SM), fine to medium, ~10% fines, traces of roots, bright brown, moist
	E - M		
	E - M		3' - 6': Poorly Graded SAND with Silt (SP-SM), fine to medium, 5-10% fines, 10-15% fine gravel, bright brown, moist
5 ft	E - M		
	E - M		
	E - M		6' - 11': Poorly Graded SAND (SP), medium to coarse, ~5% fines, ~10% gravel, light tan, moist
	E - M		
	E - M		
10 ft	E - M		
	E - M		
			Bottom of test pit at 11 feet. Backfilled with excavated material compacting in lifts.
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1. The elevation was interpolated from plan titled " Plymouth South HS Survey," by CHA Consulting, Inc., dated 1/29/14, and is approximate.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	08/12/14
Excavation Foreman : Rob Bishop		Date Completed:	08/12/14
LGCI Engineer:	Geetha Mathiyalakan	Location:	Proposed parking - NW side
Ground Surface El:	Est. 212.5 ft (see remark 1)	Total Depth:	11.5 feet (see remark 2)
Groundwater Depth:	Seeped at 8 ft	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	3' to 6' x 9'

Depth Scale	Exc. Effort	Strata	Soil Description
	E	**Topsoil/ Subsoil ~1'**	8": Topsoil 8" - 1': Silty SAND (SM), fine to medium, ~15% fines, ~5% organics, brown, moist (subsoil)
	E - M	**Fill**	1' - 9': Poorly Graded SAND with Silt (SP-SM), fine to medium, 5-10% fines, 10 - 15% coarse gravel and cobbles up to 8 inches, brown-tan, moist (fill)
	M		
	M		
5 ft	M		
	M		
	M		
	M		
	M		
	M		
10 ft	M	~10.5'	9' - 10.5': Poorly Graded SAND with Silt (SP-SM), fine to medium, ~10% fines, 5-10% organics, 5-10% small to medium size roots, one ~6" dia stump ~2 feet long, exposed another ~6" dia stump on the side of test pit, bright brown-gray, wet (fill)
	M	**Sand**	10.5' - 11.5': Poorly Graded SAND with Silt (SP-SM), fine to medium, ~10% fines, bright brown-tan, wet
	M		Bottom of test pit at 11.5 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate compactor
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

2 - Excavated sides in the fill were stable. When excavated below 10 feet test pit sides did not stay open below 10.5 feet.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	08/12/14
Excavation Foreman : Rob Bishop		Date Completed:	08/12/14
LGCI Engineer:	Geetha Mathiyalakan	Location:	Proposed parking - NW side
Ground Surface El:	Est. 213 ft (see remark 1)	Total Depth:	10.5 feet (see remark 2)
Groundwater Depth:	Standing water at 6 ft	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	3' to 7' x 9'

Depth Scale	Exc. Effort	Strata	Soil Description
	E	Topsoil/ Subsoil ~1'	8": Topsoil 8" - 1': Silty SAND (SM), fine to medium, 15-20% fines, ~5% fine gravel, <5% organics, brown, moist (subsoil)
	E - M	Fill	1' - 3.5': Poorly Graded SAND with Silt (SP-SM), fine to medium, ~10% fines, 5-10% fine gravel, <5% cobbles up to 6 inches, tan-brown, moist (fill)
	M		
	M		3.5' - 4': Poorly Graded SAND (SP), fine to medium, ~5% fines, dark gray, moist (fill)
5 ft	M		4' - 6': Poorly Graded SAND with Silt (SP-SM), fine to medium, ~10% fines, thin (~2") layer of organics, one tree log ~8" dia and ~2 feet long, exposed another tree log ~10" dia, 5-10% medium size roots, bright brown to brown, moist to wet at 6 feet
	M		
	M		6' - 10': Poorly Graded SAND with Silt (SP-SM), fine to medium, 5-10% fines, ~10% organics, ~20% small to medium size roots, dark gray, wet (fill)
	M		
	M		
10 ft	M	~10'	
	M	Sand	10' - 10.5': Poorly Graded SAND (SP), fine to medium, ~5% fines, tan-brown, wet
			Bottom of test pit at 10.5 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate compactor
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

2- Unstable sides below 4 feet. Test pit could not be excavated deeper below 10.5 feet due to unstable sides.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	08/12/14
Excavation Foreman : Rob Bishop		Date Completed:	08/12/14
LGCI Engineer:	Geetha Mathiyalakan	Location:	Proposed parking - southern side
Ground Surface El:	Est. 213.5 ft (see remark 1)	Total Depth:	11 feet
Groundwater Depth:	Seeped between 3.5 ft & 4.5 ft (see remark 2)	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	3' x 8'

Depth Scale	Exc. Effort	Strata	Soil Description
	E	Topsoil/ Subsoil ~0.8'	6": Topsoil 6" - 0.8': Silty SAND (SM), fine to medium, ~15% fines, ~5% fine gravel, <5% organics, brown, moist (subsoil)
	E - M	Fill	0.8' - 3.5': Poorly Graded SAND with Silt (SP-SM), fine to medium, ~10% fines, <5% fine gravel, tan-brown, moist (fill)
	M		
	M	5.5'	3.5' - 4.5': Silty SAND (SM), fine, 15-20% fines, 5-10% organics, 5-10% small to medium size roots, dark gray, wet (fill)
5 ft	M	Sand	4.5' - 7': Silty SAND (SM), mostly fine, 10-15% fines, <5% fine gravel, bright brown, moist
	M		
	M		
	M		7' - 11': Poorly Graded SAND (SP), fine to medium, ~5% fines, tan, moist
	M		
10 ft	M		
	M		
			Bottom of test pit at 11 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate compactor
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

2 - No standing water observed at the bottom of test pit.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	08/12/14
Excavation Foreman : Rob Bishop		Date Completed:	08/12/14
LGCI Engineer:	Geetha Mathiyalakan	Location:	Proposed parking - southern side
Ground Surface El:	Est. 213.5 ft (see remark 1)	Total Depth:	10.5 feet (see remark 2)
Groundwater Depth:	Not encountered	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	3' to 5' x 9'

Depth Scale	Exc. Effort	Strata	Soil Description
	E	Topsoil/ Subsoil	9": Topsoil 9" - 0.8': Silty SAND (SM), fine to medium, ~15% fines, brown, moist (subsoil)
	E - M	Fill	0.8' - 2.6': Silty SAND (SM), fine to medium, ~15% fines, 5-10% fine gravel, brown, moist (fill)
	E - M	~3.4'	2.6' - 3': thin (~5") layer of buried topsoil, ~5% medium to large size roots 3' - 3.4': Silty SAND (SM), fine to medium, ~15% fines, <5% organics, bright brown, moist (buried subsoil)
	M	Sand	3.4' - 4': Poorly Graded SAND with Silt (SP-SM), fine to medium, ~10% fines, 5-10% fine gravel, bright brown, moist
5 ft	M		4' - 10.5': Poorly Graded SAND (SP), fine to medium, ~5% coarse sand, ~5% fines, <5% fine gravel, <5% cobbles up to 12 inches, tan, moist
	M		
	M		
	M		
	M		
10 ft	M		
	M		Bottom of test pit at 10.5 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate compactor
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

2 - Unstable sides below 5 feet and opened wider to 5 feet below 5 feet.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	08/11/14
Excavation Foreman : Rob Bishop		Date Completed:	08/11/14
LGCI Engineer:	Alan Smith	Location:	Proposed access road
Ground Surface El:	Est. 204.5 ft (see remark 1)	Total Depth:	11 feet (see remark 2)
Groundwater Depth:	Not encountered	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	5' x 8'

Depth Scale	Exc. Effort	Strata	Soil Description
		Topsoil ~0.5'	6": Topsoil
	E	Fill ~2'	0.5' - 2': Poorly Graded SAND with Silt (SP-SM), fine to medium, 5-10% fines, ~5% fine gravel, brown, moist (fill)
	E - M		
	M	Sand	2' - 11': Poorly Graded SAND (SP), mostly fine to medium, thin (~2") layer of coarse sand at 4 feet, ~5% fines, ~5% fine gravel, tan, moist
	M		
5 ft	M		
	M		
	M		
	M		
	M		
10 ft	M		
	M		
			Bottom of test pit at 11 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate compactor
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

2 - Test pit damaged electric line which was later fixed by the school personnel.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	08/11/14
Excavation Foreman : Rob Bishop		Date Completed:	08/11/14
LGCI Engineer:	Alan Smith	Location:	Proposed access road
Ground Surface El:	Est. 209.5 ft (see remark 1)	Total Depth:	10 feet
Groundwater Depth:	Not encountered	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	5' x 9'

Depth Scale	Exc. Effort	Strata	Soil Description
		Topsoil	4": Topsoil
	E	Fill	0.3' - 3.5': Poorly Graded SAND with Silt (SP-SM), fine to medium, 5-10% fines, ~5% fine gravel, brown, moist (fill)
	E - M		
	M		
		~3.5'	
	M	Sand	3.5' - 6': Poorly Graded SAND with Silt (SP-SM), mostly fine, ~5% medium, 5-10% fines, ~5% fine gravel, bright brown, moist
5 ft	M		
	M		
	M		6' - 8': Poorly Graded SAND (SP), mostly fine, ~5% medium, ~5% fines, brown, moist
	M		
	M		8' - 10': Poorly Graded SAND (SP), mostly fine to medium, ~5% coarse, <5% fines, tan, moist
10 ft	M		
			Bottom of test pit at 11 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate compactor
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	08/11/14
Excavation Foreman : Rob Bishop		Date Completed:	08/11/14
LGCI Engineer:	Alan Smith	Location:	Proposed access road
Ground Surface El:	Est. 209.5 ft (see remark 1)	Total Depth:	10 feet
Groundwater Depth:	Not encountered	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	4.5' x 7'

Depth Scale	Exc. Effort	Strata	Soil Description
		Topsoil ~0.7'	8": Topsoil
	E	**Fill ~3'**	0.7' - 3': Poorly Graded SAND with Silt (SP-SM), mostly fine, ~5% medium, 5-10% fines, brown-gray, moist (fill)
	E - M		
	M		
	M	**Sand**	3' - 10': Poorly Graded SAND (SP), mostly fine to medium, ~5% coarse, <5% fines, 10-15% fine gravel, tan, moist
5 ft	M		
	M		
	M		
	M		
	M		
10 ft	M		
			Bottom of test pit at 10 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate compactor
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	08/12/14
Excavation Foreman : Rob Bishop		Date Completed:	08/12/14
LGCI Engineer:	Geetha Mathiyalakan	Location:	SE side of existing football field
Ground Surface El:	Est. 210.5 ft (see remark 1)	Total Depth:	11 feet (see remark 2)
Groundwater Depth:	Not encountered	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	5' to 7' x 10'

Depth Scale	Exc. Effort	Strata	Soil Description
	E	**Topsoil/ Subsoil ~1.3'**	8": Topsoil 8" - 1.3': Silty SAND (SM), fine to medium, ~20% fines, <5% organics, bright brown, moist (subsoil)
	E - M	**Fill**	1.3' - 1.8': Poorly Graded SAND with Silt (SP-SM), fine to medium, ~10% fines, ~10% fine gravel, brown, moist (fill)
	E - M	**Sand**	1.8' - 2.7': Poorly Graded SAND with Silt (SP-SM), fine to medium, ~10% fines, brown-tan, moist
	E - M		2.7' - 11': Poorly Graded SAND (SP), fine to medium, ~5% fines, <5% fine gravel, tan, moist
5 ft	E - M		
	E - M		
	M		
	M		
	M		
10 ft	M		
	M		
			Bottom of test pit at 11 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate compactor
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

2 - Unstable sides below 3 feet and opened wider to 7 feet below 3 feet.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	08/11/14
Excavation Foreman : Rob Bishop		Date Completed:	08/11/14
LGCI Engineer:	Alan Smith	Location:	Proposed access road
Ground Surface El:	Est. 209.5 ft (see remark 1)	Total Depth:	10 feet
Groundwater Depth:	Not encountered	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	5' x 7'

Depth Scale	Exc. Effort	Strata	Soil Description
	E	Topsoil ~1'	12": Topsoil
	E - M	Fill	0.7' - 3': Poorly Graded SAND with Silt (SP-SM), mostly fine, ~5% medium, 5-10% fines, brown-gray, moist (fill)
	M		
	M	~4'	
5 ft	M	Sand	4' - 10': Poorly Graded SAND (SP), mostly fine to medium, <5% fines, <5 fine gravel, tan with thin (~2") layers of bright brown in the top 2 feet, moist
	M		
	M		
	M		
	M		
10 ft	M		
			Bottom of test pit at 10 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate compactor
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	08/11/14
Excavation Foreman : Rob Bishop		Date Completed:	08/11/14
LGCI Engineer:	Alan Smith	Location:	Proposed access road
Ground Surface El:	Est. 206.5 ft (see remark 1)	Total Depth:	11 feet
Groundwater Depth:	Not encountered	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	5' x 7'

Depth Scale	Exc. Effort	Strata	Soil Description
		Topsoil ~0.7'	8": Topsoil
	E	**Fill**	0.7' - 8': Poorly Graded SAND with Silt (SP-SM), fine to medium, 5-10% fines, 5-10% fine gravel, brown, moist (fill)
	E - M		
	M		
	M		
5 ft	M		Thin (~1") black layer of possible wood ash at 4 feet
	M		
	M		
	M		
	M		
	M		8' - 10': Silty SAND (SM), mostly fine to medium, 15-20% fines, gray, moist
10 ft	M	~10'	
	M	**Sand**	10' - 11': Poorly Graded SAND (SP), mostly fine to medium, <5% fines, tan, moist
			Bottom of test pit at 11 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	08/12/14
Excavation Foreman : Rob Bishop		Date Completed:	08/12/14
LGCI Engineer:	Geetha Mathiyalakan	Location:	Proposed access road
Ground Surface El:	Est. 210 ft (see remark 1)	Total Depth:	10.5 feet (see remark 2)
Groundwater Depth:	Not encountered	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	4.5' x 9'

Depth Scale	Exc. Effort	Strata	Soil Description
		Topsoil ~0.6'	7": Topsoil
	E	**Fill** ~5'	0.6' - 5': Poorly Graded SAND with Silt (SP-SM), fine to medium, ~10% fines, 5-10% fine to coarse gravel, brown, moist (fill)
	E - M		
	E - M		
	M		
5 ft	M		
	M	**Sand**	5' - 10.5': Poorly Graded SAND (SP), fine to medium, ~5% fines, tan with occasional thin (~1") layers of bright brown, moist
	M		
	M		7' - 10.5': Poorly Graded SAND (SP), mostly medium, ~5% coarse, ~5% fines, <5% fine gravel, tan, moist
	M		
10 ft	M		
	M		Bottom of test pit at 10.5 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate compactor
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

2 - Encountered an existing sewer line at about 5 feet which was later fixed by the school. Moved about 6 ft away and excavated to 10.5 feet.

LGCI
Lahlaf Geotechnical Consulting, Inc.

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Excavation Subcontractor: JC Engineering, Inc.		Date Started:	08/12/14
Excavation Foreman : Rob Bishop		Date Completed:	08/12/14
LGCI Engineer:	Geetha Mathiyalakan	Location:	Proposed parking - NE side
Ground Surface El:	Est. 214 ft (see remark 1)	Total Depth:	10 feet (see remark 2)
Groundwater Depth:	Not encountered	Excavator Type:	KUBOTA KX080-3
		Test Pit Dimensions:	3.5' to 7' x 9'

Depth Scale	Exc. Effort	Strata	Soil Description
	E	**Topsoil/ Subsoil ~0.9'**	8": Topsoil 8" - 0.9': Silty SAND (SM), fine to medium, ~20% fines, <5% organics, bright brown, moist (subsoil)
	E - M	**Fill ~2'**	0.9' - 2': Poorly Graded SAND with Silt (SP-SM), fine to medium, ~10% fines, 5-10% fine gravel, ~5% cobbles up to 6 inches, brown, moist (fill)
	E - M	**Sand**	2' - 3': Poorly Graded SAND (SP), fine to medium, ~5% fines, thin (~2") layer of fine to coarse gravel, dark tan, moist
	E - M		3' - 8': Poorly Graded SAND (SP), fine to medium, <5% fines, 5-10% mostly coarse gravel, tan, moist
5 ft	E - M		
	E - M		
	E - M		
	E - M		
	E - M		
	E - M		8' - 10': Poorly Graded SAND (SP), fine to medium, ~5% fines, ~5% cobbles up to 6 inches, tan, very moist
10 ft	E - M		
			Bottom of test pit at 10 feet. Backfilled with excavated material. Compacted in lifts in the top 6 feet with plate compactor
15 ft			

Remarks: E = Easy, M = Moderate, D = Difficult, V = Very Difficult

1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

2 - Unstable sides below 1.5 feet and opened wider to 7 feet below 1.5 feet.

Appendix B Boring Logs and Groundwater Observation Well Installation Report

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	Northern Drill Sevice, Inc.	Date Started:	4/5/2014
Drilling Foreman:	Chris De Villers	Date Completed:	4/5/2014
LGCI Engineer:	Geetha Mathiyalakan	Location:	Western side of proposed building
Ground Surface El:	213.5 feet (see remark 1)	Total Depth:	42 feet
Groundwater Depth:	Perched water at 10 ft (wet sample S3)	Drill Rig Type:	Mobile B-48 ATV
		Drilling Method:	3-1/4" HSA
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Automatic	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
									2	Topsoil/ Subsoil	~7" Topsoil 7" - 18": Silty SAND (SM), fine to medium, ~15% fines, traces of organics, brown, moist (subsoil)
	2 - 4	S1	11	8	8	9	24	2		Fill	S1 - Silty SAND (SM), mostly fine, ~5% fine gravel, gravel piece at the tip of the spoon, ~15% fines, traces of organics, brown, moist (fill)
5ft											2' - 5' auger cuttings: Silty SAND (SM), fine to medium, 10-15% fines, ~5% fine to coarse gravel, brown, moist (fill)
	5 - 7	S2	3	6	7	10	24	13			S2 - Poorly Graded SAND (SP), fine to medium, ~5% fines, <5% fine gravel, brown-tan, moist (fill)
10ft											
	10 - 12	S3	9	15	10	8	24	16			S3 - Top 7": Silty SAND (SM), fine to medium, 10-15% fines, brown, wet (fill) Mid 4": Silty SAND (SM), fine to medium, ~15% fines, traces of organics, traces of roots, dark gray, wet (fill)
	12 - 14	S4	11	13	11	11	24	18			Bot. 5": Silty SAND (SM), fine to medium with occasional thin (~1/4") seams of medium sand, 10-15% fines, brown with thin seams of reddish brown, wet (fill)
									3		
15ft										~15'	S4 - Top 4": Similar to bot. 5" of S3 (fill) Bot. 14": Silty SAND (SM), fine, ~15% fines, thin (~1/8") seams of organics, gray with seams of reddish brown in bottom 3 inches, moist (fill)
	15 - 17	S5	4	7	10	12	24	12		Sand	S5 - Poorly Graded SAND (SP), fine to medium, ~5% fines, tan, moist
	17 - 19	S6	9	9	14	16	24	14			S6 - Similar to S5, thin (~1") layer of fine to coarse angular gravel in the middle of the sample, tan, moist
20ft											
	20 - 22	S7	7	8	9	10	24	15			S7 - Poorly Graded SAND (SP), fine to medium, ~5% coarse, ~5% fines, tan, moist

Remarks:
1. The elevation was interpolated from plan titled " Plymouth South HS Survey," by CHA Consulting, Inc., dated 1/29/14, and is approximate.
2 - Boring was advanced with a posthole digger to 18 inches to clear irrigation pipes.
3 - Based on drilling action, possible cobble at 14 feet.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**
Client:	**Ai3 Architects LLC** — LGCI Project No.: 1408

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	25 - 27	S8	9	11	11	13	24	16		Sand	S8 - Poorly Graded SAND (SP), mostly medium, 5-10% coarse, <5% fines, tan, moist
30 ft	30 - 32	S9	8	12	13	16	24	17			S9 - Similar to S8, fine to medium sand at the tip of the spoon, <5% fines, tan, moist
35 ft	35 - 37	S10	9	14	18	20	24	18			S10 - Poorly Graded SAND (SP), fine to medium, <5% fines, <5% fine gravel, tan with occasional thin (~1/16") dark seams, moist
40 ft	40 - 42	S11	7	13	16	16	24	14			S11 - Similar to S10
45 ft											End of boring at 42 feet. Backfilled with drill cuttings.
50 ft											

Remarks:

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	Northern Drill Sevice, Inc.	Date Started:	4/5/2014
Drilling Foreman:	Chris De Villers	Date Completed:	4/5/2014
LGCI Engineer:	Geetha Mathiyalakan	Location:	Western side of proposed building
Ground Surface El:	214 feet (see remark 1)	Total Depth:	42 feet
Groundwater Depth:	Perched water between 2 ft and 9 ft (wet samples)	Drill Rig Type:	Mobile B-48 ATV
		Drilling Method:	3-1/4" HSA
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Automatic	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
									2	Topsoil/ Subsoil	~6" Topsoil 6" - 14": Silty SAND (SM), fine to medium, ~15% fines, traces of organics, brown, moist (subsoil)
	2 - 4	S1	9	9	7	11	24	20		Fill	S1 - Top 12": Poorly Graded SAND (SP), mostly medium, ~5% fines, brown, wet (fill) Bot. 8": Silty SAND (SM), mostly fine, 25-30% fines, 5 - 10% fine gravel, thin (~1/16") seams of organics, traces of roots, brown, moist (fill)
5ft											
	5 - 7	S2	3	6	6	9	24	17			S2 - Top 5": Silty SAND (SM), fine to medium, 25-30% fines, 5-10% fine gravel, gray-brown, wet (fill) Bot. 12": Poorly Graded SAND with Silt (SP-SM), mostly medium, 5-10% fines, <5% fine gravel, brown, wet (fill)
	7 - 9	S3	12	14	12	27	24	16			S3 - Silty SAND (SM), mostly fine, mostly brown medium sand in the middle, 5", 15-20% fines, traces of organics in the top 5 inches, brown-gray, wet (fill)
10ft											
	10 - 12	S4	2	9	6	6	24	14			S4 - Top 9": Silty SAND (SM), fine to medium, ~15% fines, 10-15% fine gravel, traces of roots, gray, moist (fill)
									3	~12'	Bot. 5": Silty SAND (SM), fine, ~15% fines, traces of roots, ~ 1" of organic soil, brown, moist (buried subsoil)
	12 - 14	S5	3	3	5	7	24	14		Sand	S5 - Silty SAND (SM), mostly fine at the top 9 inches to fine to medium below, ~15% fines, 10-15% fine gravel, bright brown in the top 9 inches to tan below, moist
15ft											
	15 - 17	S6	4	6	7	8	24	11			S6 - Poorly Graded SAND (SP), mostly fine, ~5% fines, <5% fine gravel, tan, moist
	17 - 19	S7	7	6	5	7	24	15			S7 - Poorly Graded SAND (SP), mostly medium, 5-10% coarse, <5% fines, light tan, moist
20ft											
	20 - 22	S7	3	5	5	6	24	15			S8 - Similar to S7

Remarks:
1. The elevation was interpolated from plan titled " Plymouth South HS Survey," by CHA Consulting, Inc., dated 1/29/14, and is approximate.
2 - Boring was advanced with a posthole digger to 18 inches to clear irrigation pipes.
3 - Estimated strata change based on observed drilling condition.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**	
Client:	**Ai3 Architects LLC**	LGCI Project No.: 1408

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	25 - 27	S9	5	7	8	9	24	15		Sand	S9 - Poorly Graded SAND (SP), fine to medium, <5% fines, <5% fine gravel, light tan, moist
30 ft	30 - 32	S10	3	8	9	8	24	14			S10 - Poorly Graded SAND (SP), mostly medium, <5% fines, <5% fine gravel, light tan, moist
35 ft	35 - 37	S11	7	9	12	14	24	14			S11 - Poorly Graded SAND (SP), mostly fine, <5% fines, light tan, moist
40 ft	40 - 42	S12	6	10	11	12	24	13			S12 - Poorly Graded SAND (SP), fine to medium with occasional thin (~1/2") layers of medium, ~5% fines, light tan, moist
45 ft											End of boring at 42 feet. Backfilled with drill cuttings. Moved 3 ft to the west and installed an observation well to 17 ft.
50 ft											

Remarks:

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	Northern Drill Sevice, Inc.	Date Started:	4/6/2014
Drilling Foreman:	Tim Tucker	Date Completed:	4/7/2014
LGCI Engineer:	A. Smith / G. Mathiyalakan	Location:	Near center of proposed building
Ground Surface El:	216 feet (see remark 1)	Total Depth:	66 feet
Groundwater Depth:	Not encountered	Drill Rig Type:	Mobile B-48 ATV
		Drilling Method:	3-1/4" HSA to 40 ft / 4-in casing to 64 ft
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Automatic	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
									2	Topsoil/ Subsoil ~1.2'	~7" Topsoil 7" - 14": Silty SAND (SM), fine to medium, 10-15% fines, traces of roots, brown, moist (subsoil)
	2 - 4	S1	13	10	9	8	24	21		Fill	S1 - Top 12": Silty SAND (SM), mostly fine, 15-20% fines, ~5% gravel, traces of roots, dark brown, moist (fill) Bot. 9": Poorly Graded SAND with Silt (SP -SM), fine to medium, 5-10% fines, 5-10% fine gravel, orange-brown, moist (buried subsoil)
									3	~4'	
5ft	4 - 6	S2	4	4	6	7	24	18		Sand	S2 - Poorly Graded SAND (SP), fine to medium, ~5% coarse, 10-15% fine gravel, tan, moist
	6 - 8	S3	7	7	9	9	24	18			S3 - Similar to S2, 10-15% fine gravel
	8 - 10	S4	4	6	8	10	24	6			S4 - Poorly Graded SAND (SP), fine to medium, ~5% fines, ~1" subangular gravel piece at the tip of the spoon, tan, moist
10ft	10 - 12	S5	7	5	6	8	24	15			S5 - Poorly Graded SAND (SP), mostly medium, ~5% coarse, <5% fines, tan, moist
	12 - 14	S6	6	6	9	8	24	16			S6 - Poorly Graded SAND (SP), fine to medium, ~5% fines, ~5% fine gravel, tan with occasional thin (~1/8") dark seams, moist
15ft	14 - 16	S7	7	8	10	12	24	12			S7 - Poorly Graded SAND (SP), mostly medium, ~5% coarse, ~5% fines, tan, moist
20ft	20 - 22	S8	6	10	11	13	24	17			S8 - Poorly Graded SAND (SP), fine to medium with occasional thin (~1/4") layers of medium, ~5% fines, tan, moist

Remarks:
1. The elevation was interpolated from plan titled " Plymouth South HS Survey," by CHA Consulting, Inc., dated 1/29/14, and is approximate.
2 - Boring was advanced with a posthole digger to 18 inches to clear irrigation pipes.
3 - Estimated strata change based on observed drilling condition.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**
Client:	**Ai3 Architects LLC** — LGCI Project No.: 1408

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	25 - 27	S9	6	13	14	14	24	16		Sand	S9 - Poorly Graded SAND (SP), mostly medium, <5% fines, <5% fine gravel, tan, moist
30 ft	30 - 32	S10	9	12	13	17	24	17			S10 - Poorly Graded SAND (SP), fine to medium, ~5% fines, ~5% fine gravel, tan, moist
35 ft	35 - 37	S11	7	11	14	15	24	17			S11 - Poorly Graded SAND (SP), fine to medium, <5% coarse, <5% fines, tan, moist
40 ft	40 - 42	S12	10	21	18	20	24	16	4		S12 - Poorly Graded SAND (SP), fine to medium, ~5% fines, tan, moist
45 ft	44 - 46	S13	12	19	24	25	24	2	5		S13 - Similar to S12, traces of fine gravel piece sat the tip of the spoon, tan, wet
50 ft	49 - 51	S14	12	17	21	21	24	9			S14 - Poorly Graded SAND (SP), mostly fine to medium, <5% coarse, ~5% fines, tan, wet
	54 - 56	S15	5	9	15	21	24	3			S15 - Poorly Graded SAND (SP), fine to medium, ~5% fines, <5% fine gravel, tan, wet

Remarks:
4 - Advanced with 3-1/4" HSA to 40 ft and switched to 4-in casing after split spoon sample S12.
5 After S13, attempted to advance the bore hole with drill mud and roller bit, but lost drill water then switched to drive and wash.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**
Client:	**Ai3 Architects LLC** — LGCI Project No.: 1408

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
60 ft	59 - 61	S16	34	100	50/2"		14	6		Sand	S16 - Well Graded SAND (SW), mostly fine to medium, 10-15% coarse, ~5% fines, tan, wet
65 ft	64 - 66	S17	15	33	40	31	24	10			S17 - Poorly Graded SAND (SP), mostly fine to medium, occasional thin (~1/8") layers of coarse sand, 5-10% gravel, 5% fines, tan, wet
									6		
											End of boring at 66 feet. Backfilled with drill cuttings.
70 ft											
75 ft											
80 ft											

Remarks:
6 - Attempted to take a split spoon sample after S17 with 4-in casing at 64 ft but borehole collapsed to 64 ft.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	Northern Drill Sevice, Inc.	Date Started:	4/6/2014
Drilling Foreman:	Chris De Villers	Date Completed:	4/6/2014
LGCI Engineer:	Alan Smith	Location:	Eastern side of proposed building
Ground Surface El:	213 feet (see remark 1)	Total Depth:	42 feet
Groundwater Depth:	Not encountered	Drill Rig Type:	Mobile B-48 ATV
		Drilling Method:	3-1/4" HSA
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Automatic	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
									2	Topsoil/ Subsoil	~7" Topsoil, traces of gravel, ~2" Subsoil
										Fill	9" - 18": Silty SAND (SM), fine to medium, ~5% coarse, ~15% fines, 5-10% fine gravel, brown, moist (fill)
	2 - 4	S1	20	14	9	11	24	22			S1 - Poorly Graded SAND with Silt (SP-SM), fine to medium, 10-15% fines, 10-15% gravel, brown, moist (fill)
5ft									3	~5'	
	5 - 7	S2	3	3	5	6	24	19		Sand	S2 - Poorly Graded SAND (SP), fine to medium, occasional thin (~1") layers of fine to coarse sand, ~5% fines, ~5% fine gravel, tan, moist
	7 - 9	S3	6	5	6	7	24	19			S3 - Similar to S2
10ft											
	10 - 12	S4	3	6	7	8	24	18			S4 - Similar to S2, occasional thin (~1/2") layers of silty fine sand, tan, moist
									4		
15ft											
	15 - 17	S5	5	12	13	12	24	15			S5 - Poorly Graded SAND with Gravel (SP), mostly medium, 5-10% coarse, <5% fines, 15-20% gravel, tan, moist
20ft											
	20 - 22	S6	6	8	10	11	24	19			S6 - Poorly Graded SAND (SP), fine to medium, <5% fines, dark tan to tan, moist

Remarks:
1. The elevation was interpolated from plan titled " Plymouth South HS Survey," by CHA Consulting, Inc., dated 1/29/14, and is approximate.
2 - Boring was advanced with a posthole digger to 18 inches to clear irrigation pipes.
3 - Estimated strata change based on observed drilling condition.
4 - Based on drilling action possible cobble at 14 feet.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**
Client:	**Ai3 Architects LLC** — LGCI Project No.: 1408

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	25 - 27	S7	7	18	16	14	24	15		Sand	S7 - Poorly Graded SAND (SP), fine to medium, <5% fines, 10-15% gravel in the top 7 inches, dark tan to tan, moist
30 ft	30 - 32	S8	8	12	15	16	24	18			S8 - Poorly Graded SAND (SP), fine to medium, <5% fines, thin (~2") layer of gravel, dark tan to tan, moist
35 ft	35 - 37	S9	7	10	15	17	24	20			S9 - Poorly Graded SAND (SP), fine to medium, <5% fines, dark tan to tan, moist
40 ft	40 - 42	S10	7	11	12	13	24	20			S10 - Similar to S9
45 ft											End of boring at 42 feet. Backfilled with drill cuttings. Moved 3.5 ft and drilled to 16 ft and took continuous samples.
50 ft											

Remarks:

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	Northern Drill Sevice, Inc.	Date Started:	4/5/2014
Drilling Foreman:	Chris De Villers	Date Completed:	4/6/2014
LGCI Engineer:	G. Mathiyalakan / A. Smith	Location:	Eastern side of proposed building
Ground Surface El:	214 feet (see remark 1)	Total Depth:	42 feet
Groundwater Depth:	Not encountered	Drill Rig Type:	Mobile B-48 ATV
		Drilling Method:	3-1/4" HSA
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Automatic	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
									2	Topsoil/ Subsoil	~6" Topsoil 6" - 12": Silty SAND (SM), mostly fine, 20-25% fines, traces of organics, brown, moist (subsoil)
	2 - 4	S1	10	12	9	7	24	18		Fill	12" - 18": Silty SAND with Gravel (SM), mostly fine, ~20% fines, 10-15% gravel, brown, moist (fill) S1 - Top 3": Silty SAND (SM), mostly fine, ~15% fines, brown, moist (fill)
5ft											
	5 - 7	S2	2	2	3	4	24	13			Bot. 15": Poorly Graded SAND with Gravel (SP), fine to medium, ~5% fines, ~30% mostly coarse angular gravel, tan, moist (fill)
									3	~7'	
	7 - 9	S3	3	4	5	4	24	16		Sand	S2 - Poorly Graded SAND (SP), mostly medium, ~5% fines, ~5% fine gravel, tan, moist (fill) S3 - Poorly Graded SAND (SP), fine to medium, ~5% fines, ~5% fine gravel, tan with occasional thin (~1/16") dark and reddish brown seams, moist
10ft											
	10 - 12	S4	2	4	5	4	24	17			S4 - Poorly Graded SAND (SP), mostly fine, ~5% medium, <5% fines, <5% fine gravel, tan with occasional thin gray lenses, moist
15ft											
	15 - 17	S5	4	5	6	8	24	20			S5 - Poorly Graded SAND (SP), fine to medium, occasional thin (~1") layer of medium sand, <5% fines, tan, moist
20ft											
	20 - 22	S6	5	9	11	15	24	20			S6 - Similar to S5

Remarks:
1. The elevation was interpolated from plan titled " Plymouth South HS Survey," by CHA Consulting, Inc., dated 1/29/14, and is approximate.
2 - Boring was advanced with a posthole digger to 18 inches to clear for irrigation utilities.
3 - Estimated strata change based on observed drilling condition.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**	
Client:	**Ai3 Architects LLC**	LGCI Project No.: 1408

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	25 - 27	S7	9	12	13	13	24	20		Sand	S7 - Poorly Graded SAND (SP), fine to medium, occasional thin (~1") layer of medium sand, <5% fines, tan, moist
30 ft	30 - 32	S8	7	9	13	16	24	20			S8 - Similar to S7
35 ft	35 - 37	S9	9	12	13	14	24	19			S9 - Similar to S7
40 ft	40 - 42	S10	7	12	16	21	24	19			S10 - Similar to S7
45 ft											End of boring at 42 feet. Backfilled with drill cuttings.
50 ft											

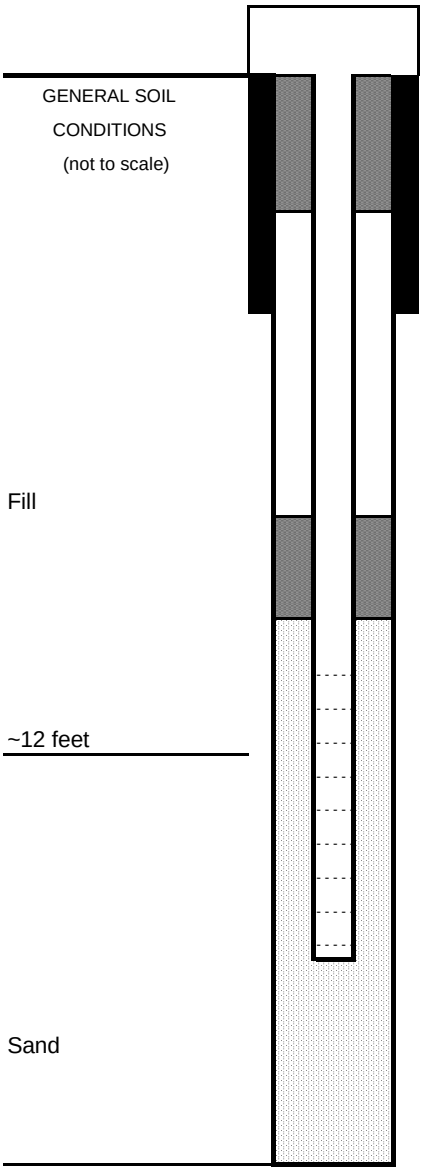
Remarks:

LGCI
Lahlaf Geotechnical Consulting, Inc.

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Boring No. : **B-2-OW**

Project Name:	**Proposed Plymouth South High School, Plymouth, Massachusetts**		
LGCI Project Number:	**1408**		
Client:	**Ai3 Architects LLC**		
Drilling Subcontractor:	Northern Drill Service, Inc.	Date Started:	4/7/14
Drilling Foreman:	Tim Tucker	Date Completed:	4/7/14
LGCI Engineer:	Geetha Mathiyalakan	Location:	Western side of proposed building
Ground Surface Elevation:	214.0 ft (see remark 1)	Total Depth of Boring:	17 feet
Ground Water Depth:	8.3 ft at the end of installation	Drill Rig Type:	Mobil B-48 ATV
		Drilling Method:	3 1/4" HSA



Riser Stickup ~ 5 inches below ground surface

THICKNESS OF SURFACE SEAL	~ 6 inches
TYPE OF SURFACE SEAL	Concrete
TYPE OF SURFACE CASING	Roadbox
ID OF SURFACE CASING	4 inches
DEPTH TO BOTTOM OF CASING	10 inches
ID OF RISER PIPE	2 inches
TYPE OF RISER PIPE	Schedule 40 PVC
TYPE OF BACKFILL AROUND RISER PIPE	Sand
DEPTH TO TOP OF SEAL	3 feet
TYPE OF SEAL	Bentonite chips
DEPTH TO BOTTOM OF SEAL	5 feet
DEPTH TO TOP OF PERVIOUS SECTION	7 feet
TYPE OF PERVIOUS SECTION	Schedule 40 PVC
DESCRIBE OPENINGS	0.01-inch slots
ID OF PERVIOUS SECTION	2 inches
TYPE OF BACKFILL AROUND PERVIOUS SECTION	Filter Sand
DEPTH TO BOTTOM OF PERVIOUS SECTION	17 feet
DEPTH TO BOTTOM OF SAND COLUMN	17 feet
TYPE OF BACKFILL BELOW PERVIOUS SECTION	Filter Sand
DIAMETER OF BOREHOLE	6 inches
DEPTH TO BOTTOM OF BOREHOLE	17 feet

NOTES:

1 - Ground surface elevation estimated from plan titled " Plymouth South HS Survey," dated January 29, 2014, by CHA Consulting, Inc.

LGCI
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BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	New Hampshire Boring	Date Started:	8/15/2014
Drilling Foreman:	Ernie Nadeau	Date Completed:	8/15/2014
LGCI Engineer:	Geetha Mathiyalakan	Location:	Proposed parking - NW side
Ground Surface El:	213 feet (see remark 1)	Total Depth:	17 feet
Groundwater Depth:	4.8 ft at the end of drilling	Drill Rig Type:	Morooka D-50 Rubber Tire ATV
	Wet samples below 5 feet	Drilling Method:	2-1/4" HSA
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Safety	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0 - 2	S1	4	5	8	13	24	17		Topsoil/ Fill ~10.9'	S1 - Top 5": Topsoil Mid 2": Silty SAND (SM), fine to medium, ~15% fines, ~5% organics, brown, moist (subsoil) Bot. 7": Poorly Graded SAND with Silt (SP-SM), mostly fine to medium, 5-10% fines, tan-brown, moist (fill) S2 - Poorly Graded SAND (SP), mostly medium, <5% fines, <5% fine gravel, tan, wet (fill) S3 - Top 6": Similar to S2 Bot. 12": Poorly Graded SAND with Silt (SP-SM), fine to medium, 5-10% fines, thin (~3") layer of organics and ~5% roots in the middle of the sample, black-tan, wet (fill) S4 - Top 9": Poorly Graded SAND with Silt (SP-SM), fine to medium, 5-10% fines, thin (~2") layer of organics in the middle of the sample, brown-gray, wet Bot. 2": Silty SAND (SM), fine to medium, ~15% fines, bright brown, moist (buried subsoil)
5ft	5 - 7	S2	8	13	12	13	24	9			
	7 - 9	S3	6	8	16	34	24	18			
10ft	10 - 12	S4	7	12	10	11	24	11			
	12 - 14	S5	6	7	10	10	24	11		Sand	S5 - Poorly Graded SAND with Silt (SP-SM), mostly fine, 5-10% fines, brown-tan, wet
15ft	15 - 17	S6	8	12	14	14	24	10			S6 - Poorly Graded SAND (SP), fine to medium, ~5% fines, <5% coarse gravel, brown-tan, wet
20ft											End of boring at 17 feet. Backfilled with drill cuttings.

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	New Hampshire Boring	Date Started:	8/13/2014
Drilling Foreman:	Ernie Nadeau	Date Completed:	8/13/2014
LGCI Engineer:	Geetha Mathiyalakan	Location:	Proposed building - western side
Ground Surface El:	214 feet (see remark 1)	Total Depth:	36 feet
Groundwater Depth:	32 feet at the end of drilling	Drill Rig Type:	Morooka D-50 Rubber Tire ATV
		Drilling Method:	4 in casing to 29 ft / Tri-cone roller bit
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Safety	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0 - 2	S1	3	10	26	31	24	15		Topsoil/ Subsoil	S1 - Top 6": Topsoil Mid. 5": Silty SAND (SM), fine to medium, 20-25% fines, traces of roots, brown, moist (subsoil)
	2 - 4	S2	16	21	31	22	24	15		Fill	Bot. 4": Silty SAND (SM), fine to medium, 15-20% fines, brown, moist (fill) S2 - Poorly Graded SAND (SP), fine to medium, ~5% coarse, ~5% fines, <5% fine gravel, tan-brown, moist (fill)
5ft	4 - 6	S3	10	11	16	22	24	11			S3 - Similar to S2, ~5% fine gravel, tan-brown, wet (fill)
	6 - 8	S4	11	17	23	20	24	12		~7'	S4 - Top 3": Similar to S2, ~10% coarse, ~5% fines, ~5% fine gravel, tan-brown, wet (fill) Bot. 9": Silty SAND (SM), mostly fine to medium, ~20% fines, 5-10% organics, thin (~2") layer of small to medium size roots at the bottom of the sample, brown to dark gray, wet (trace of natural bright brown silty sand at the tip of the spoon)
	8 - 10	S5	9	9	10	11	24	9		Sand	S5 - Poorly Graded SAND with Silt (SP-SM), fine to medium, 5-10% fines, brown-tan, wet
10ft	10 - 12	S6	14	14	15	16	24	9			S6 - Poorly Graded SAND with Silt (SP-SM), mostly fine to medium, 5-10% fines, <5% organics, tan, wet
15ft	14 - 16	S7	5	6	7	9	24	11			S7 - Poorly Graded SAND (SP), fine to medium, ~5% fines, tan, wet
	16 - 18	S8	16	15	16	12	24	8			S8 - Similar to S7, ~5% fine gravel at the top of the sample, tan, wet
20ft	19 - 21	S9	9	12	16	23	24	12			S9 - Similar to S7, 5-10% coarse, ~5% fines, tan, wet
	24 - 26	S10	12	14	18	15	24	14			S10 - Poorly Graded SAND (SP), mostly medium, <5% fines, ~5% fine gravel, tan, wet

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**
Client:	**Ai3 Architects LLC** — LGCI Project No.: 1408

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
										Sand	
											S11 - Poorly Graded SAND (SP), fine to medium, <5% fines, ~5% fine gravel, tan, wet
30 ft	29 - 31	S11	12	19	20	21	24	11			
											S12 - No Recovery
35 ft	34 - 36	S12	10	18	20	21	24	0			
											End of boring at 36 feet. Backfilled with drill cuttings.
40 ft											
45 ft											
50 ft											

Remarks:

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	New Hampshire Boring	Date Started:	8/14/2014
Drilling Foreman:	Ernie Nadeau	Date Completed:	8/14/2014
LGCI Engineer:	Geetha Mathiyalakan	Location:	Proposed Building - west side
Ground Surface El:	214.5 feet (see remark 1)	Total Depth:	35 feet
Groundwater Depth:	4 feet at the end of drilling	Drill Rig Type:	Morooka D-50 Rubber Tire ATV
	Wet samples below 7 feet	Drilling Method:	2-1/4" HSA
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Safety	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0 - 2	S1	8	8	14	10	24	15		Topsoil/ Subsoil	S1 - Top 6": Topsoil Mid. 5": Silty SAND (SM), mostly fine, ~10% medium, ~20% fines, <5% organics, brown, moist (subsoil)
	2 - 4	S2	14	16	17	21	24	13		Fill	Bot. 4": Poorly Graded SAND (SP), fine to medium, ~5% fines, tan, moist (fill) S2 - Poorly Graded SAND with Silt (SP-SM), fine to medium, 5-10% fines, ~5% fine gravel, tan, moist (fill)
5ft											
	5 - 7	S3	5	13	15	14	24	14			S3 - Poorly Graded SAND (SP), fine to medium, ~5% coarse, ~5% fines, <5% fine gravel, tan, moist (fill) S4 - Top 13": Similar to S3, ~1" coarse gravel, tan, wet (fill)
	7 - 9	S4	25	16	19	20	24	14			Bot. 1": Silty SAND (SM), mostly fine to medium, 10-15% fines, bright brown-gray, wet (buried subsoil) S5 - Top 5": Silty SAND (SM), mostly fine to medium, 10-15% fines, <5% small roots, dark brown, wet (buried subsoil)
10ft										~10.4'	
	10 - 12	S5	4	6	5	7	24	17		Sand	Bot. 12": Poorly Graded SAND (SP), fine to medium, <5% fines, tan, wet
	12 - 14	S6	10	12	17	20	24	9			S6 - Similar to bot. 12" of S5
15ft											
	15 - 17	S7	14	15	21	22	24	12			S7 - Poorly Graded SAND (SP), mostly fine, ~5% fines, tan, wet
20ft	19 - 21	S8	7	12	15	14	24	16			S8 - Poorly Graded SAND (SP), fine to medium, ~5% fines, tan, wet
	24 - 26	S9	78	26	29	38	24	12			S9 - Poorly Graded SAND (SP), fine to medium at the top of the sample to medium below, <5% fines, tan, wet

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

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BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**
Client:	**Ai3 Architects LLC** — LGCI Project No.: 1408

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
30 ft	29 - 31	S10	16	26	27	30	24	11		Sand	S10 - Poorly Graded SAND (SP), mostly medium, ~5% coarse, <5% fines, tan, wet
	33 - 35	S11	19	30	35	44	24	10			S11 - Poorly Graded SAND (SP), mostly medium, 5-10% coarse, <5% fines, tan, wet
35 ft											
40 ft											End of boring at 35 feet. Backfilled with drill cuttings.
45 ft											
50 ft											

Remarks:

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	New Hampshire Boring	Date Started:	8/14/2014
Drilling Foreman:	Ernie Nadeau	Date Completed:	8/14/2014
LGCI Engineer:	Geetha Mathiyalakan	Location:	Proposed building - western side
Ground Surface El:	215.5 feet (see remark 1)	Total Depth:	21 feet
Groundwater Depth:	3 ft at the end of drilling	Drill Rig Type:	Morooka D-50 Rubber Tire ATV
	Wet samples below 5 feet	Drilling Method:	2-1/4" HSA
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Safety	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0 - 2	S1	4	10	13	14	24	13		Topsoil/ Subsoil	S1 - Top 6": Topsoil Mid 6": Silty SAND (SM), fine to medium, ~15% fines, <5% organics, <5% fine gravel, brown, moist (subsoil)
5ft	5 - 7	S2	8	9	9	5	24	17		Fill ~7'	Bot. 1": Poorly Graded SAND with Silt (SP-SM), mostly fine to medium, ~10% fines, bright brown, moist (fill) S2 - Top 6": Poorly Graded SAND (SP), fine to medium, ~5% fines, ~5% fine gravel, brown, wet (fill) Bot. 11": Silty SAND (SM), fine to medium, 10-15% fines, ~5% organics, 5-10% roots, thin (~2") layer of roots near the tip of the spoon, brown to gray near the tip of the spoon, wet (fill)
	7 - 9	S3					24	13	2	Sand	S3 - Poorly Graded SAND (SP), mostly medium, ~5% fines, brown-tan, wet
10ft	10 - 12	S4	6	13	18	19	24	11			S4 - Poorly Graded SAND (SP), mostly medium, ~10% coarse, <5% fines, tan, wet
15ft	14 - 16	S5	6	7	9	21	24	13			S5 - Poorly Graded SAND (SP), mostly medium, 10-15% coarse, <5% fines, ~5% fine gravel, tan, wet
20ft	19 - 21	S6	12	18	21	23	24	12			S6 - Poorly Graded SAND (SP), fine to medium, ~5% coarse, <5% fines, tan, wet
											End of boring at 21 feet. Backfilled with drill cuttings.

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.
2 - Blow counts were missed for the split spoon sample S3.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	New Hampshire Boring	Date Started:	8/14/2014
Drilling Foreman:	Ernie Nadeau	Date Completed:	8/14/2014
LGCI Engineer:	Geetha Mathiyalakan	Location:	Proposed building - western side
Ground Surface El:	215 feet (see remark 1)	Total Depth:	21 feet
Groundwater Depth:	12 ft at the end of drilling	Drill Rig Type:	Morooka D-50 Rubber Tire ATV
	Wet samples below 5 feet	Drilling Method:	2-1/4" HSA
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Safety	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0 - 2	S1	3	6	16	15	24	17		Topsoil/ Fill ~8.5'	S1 - Top 5": Topsoil Mid 3": Silty SAND (SM), fine to medium, ~15% fines, <5% roots, brown, moist (subsoil) Bot. 9": Silty SAND (SM), mostly fine to medium, 10-15% fines, <5% coarse gravel, brown to tan near the tip of the spoon, moist (fill) S2 - Top 6": Poorly Graded SAND (SP), fine to medium, ~5% fines, reddish brown, wet (fill) Bot. 5": Silty SAND (SM), fine to medium, ~15% fines, ~5% gravel, 5-10% organics with occasional thin (~1/8") layers, gray, wet (fill) S3 - Top 7": Poorly Graded SAND (SP), fine to medium, ~5% fines, brown, wet Bot. 8": Silty SAND (SM), mostly fine, ~15% fines, 5-10% organics with occasional thin (~1/16") layers, gray, wet (trace of bright brown natural silty sand at the tip of the spoon)
5ft	5 - 7	S2	8	15	22	23	24	11			
	7 - 9	S3	6	21	33	32	24	15			
10ft	9 - 11	S4	8	9	10	10	24	9		Sand	S4 - Top 6": Silty SAND (SM), fine to medium, ~15% fines, <5% small roots, brown with thin (~1/16") layers of gray, wet Bot. 3": Poorly Graded SAND with Silt (SP-SM), fine to medium, 5-10% fines, tan, wet
15ft	14 - 16	S5	5	10	10	9	24	7			S5 - Poorly Graded SAND (SP), fine to medium, <5% fines, ~5% fine gravel, tan, wet to moist near the tip of the spoon
20ft	19 - 21	S6	17	10	12	13	24	7			S6 - Poorly Graded SAND (SP), mostly medium, <5% fines, tan, wet to moist near the tip of the spoon
											End of boring at 21 feet. Backfilled with drill cuttings.

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	New Hampshire Boring	Date Started:	8/15/2014
Drilling Foreman:	Ernie Nadeau	Date Completed:	8/15/2014
LGCI Engineer:	Geetha Mathiyalakan	Location:	Proposed building - NW side
Ground Surface El:	216 feet (see remark 1)	Total Depth:	17 feet
Groundwater Depth:	Not encountered	Drill Rig Type:	Morooka D-50 Rubber Tire ATV
		Drilling Method:	2-1/4" HSA
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Safety	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0 - 2	S1	2	11	8	12	24	17		Topsoil/ Subsoil	S1 - Top 5": Topsoil Mid 7": Silty SAND (SM), fine to medium, ~15% fines, ~5% coarse gravel, <5% organics, brown, moist (subsoil)
	2 - 4	S2	15	20	26	33	24	15		Fill	Bot. 5": Poorly Graded SAND (SP), mostly medium, <5% fines, tan-brown, moist (fill) S2 - Top 10": Similar to bot. 5" of S1, ~5% fine to coarse gravel, tan-brown, moist (fill)
5ft										~5.4'	Bot. 5": Silty SAND (SM), fine to medium, 10-15% fines, <5% gravel, 5-10% organics with occasional thin (~1/16") layers, <5% small roots, gray, moist (fill) S3 - Top 5": Similar to bot. 5" of S2, ~10% organics, brown-black, moist (buried topsoil/subsoil)
	5 - 7	S3	2	6	12	19	24	17		Sand	Bot. 12": Poorly Graded SAND (SP), fine to medium, <5% fines, <5% coarse gravel, tan-brown, moist
10ft											
	10 - 12	S4	5	12	19	20	24	7			S4 - Poorly Graded SAND (SP), mostly medium, ~10% coarse, <5% fines, ~5% coarse gravel, tan, moist
15ft											
	15 - 17	S5	6	10	14	12	24	13			S5 - Similar to S4, 5-10% coarse gravel, ~1" coarse gravel near the tip of the spoon, tan, moist
20ft											End of boring at 17 feet. Backfilled with drill cuttings.

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	New Hampshire Boring	Date Started:	8/15/2014
Drilling Foreman:	Ernie Nadeau	Date Completed:	8/15/2014
LGCI Engineer:	Geetha Mathiyalakan	Location:	Proposed building - near center
Ground Surface El:	215.5 feet (see remark 1)	Total Depth:	17 feet
Groundwater Depth:	Not encountered	Drill Rig Type:	Morooka D-50 Rubber Tire ATV
		Drilling Method:	2-1/4" HSA
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Safety	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0 - 2	S1	3	7	17	10	24	9		Topsoil	S1 - Top 5": Topsoil
	2 - 4	S2	11	15	22	14	24	18		Fill	Bot. 4": Poorly Graded SAND with Silt (SP-SM), fine to medium, ~10% fines, ~5% coarse gravel, brown, moist (fill) S2 - Top 8": Poorly Graded SAND (SP), fine to medium, <5% fines, tan-brown, moist (fill) Bot. 10": Silty SAND (SM), fine to medium, ~15% fines, 5-10% organics, thin (~1") layer of wood pieces at the tip of the spoon, brown-gray, moist (fill)
5ft	5 - 7	S3	2	7	7	6	24	14		~5.8'	S3 - Top 4": Buried Topsoil Mid 5": Silty SAND (SM), fine, ~20% fines, ,5% organics, gray-brown, moist (buried subsoil) Bot. 5": Poorly Graded SAND with Silt (SP-SM), mostly fine, 5-10% fines, brown-tan, moist
10ft	10 - 12	S4	10	9	10	14	24	12		Sand	S4 - Poorly Graded SAND (SP), mostly medium, ~10% coarse, <5% fines, <5% fine gravel, tan, moist
15ft	15 - 17	S5	7	7	11	11	24	11			S5 - Similar to S4, <5% coarse, <5% fines, tan, moist
20ft											End of boring at 17 feet. Backfilled with drill cuttings.

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	New Hampshire Boring	Date Started:	8/15/2014
Drilling Foreman:	Ernie Nadeau	Date Completed:	8/15/2014
LGCI Engineer:	Geetha Mathiyalakan	Location:	Proposed building - eastern side
Ground Surface El:	214.5 feet (see remark 1)	Total Depth:	17 feet
Groundwater Depth:	Not encountered	Drill Rig Type:	Morooka D-50 Rubber Tire ATV
		Drilling Method:	2-1/4" HSA
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Safety	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0 - 2	S1	3	4	6	9	24	16		Topsoil/	S1 - Top 5": Topsoil Mid. 2": Poorly Graded SAND with Silt (SP-SM), mostly fine, ~10% fines, <5% roots, brown, moist (subsoil)
	2 - 4	S2	10	11	13	14	24	7		Fill	Bot. 9": Poorly Graded SAND with Silt (SP-SM), fine to medium, 5-10% fines, <5% coarse gravel, brown-tan, moist (fill) S2 - Poorly Graded SAND (SP), mostly medium, 5% coarse, <5% fines, brown-tan, moist (fill)
5ft										~5.1'	S3 - Top 2": Similar to S2, bright brown, moist (fill)
	5 - 7	S3	3	6	29	11	24	13		Sand	Bot. 11": Poorly Graded SAND (SP), mostly medium, ~10% coarse, <5% fines, ~5% fine gravel, tan, moist
10ft	10 - 12	S4	8	11	14	13	24	8			S4 - Poorly Graded SAND (SP), mostly medium, ~10% coarse, <5% fines, <5% fine gravel, tan, moist
15ft	15 - 17	S5	8	14	16	15	24	17			S5 - Poorly Graded SAND (SP), mostly medium, <5% fines, ~5% coarse gravel, tan, moist
20ft											End of boring at 17 feet. Backfilled with drill cuttings.

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	New Hampshire Boring	Date Started:	8/15/2014
Drilling Foreman:	Ernie Nadeau	Date Completed:	8/15/2014
LGCI Engineer:	Geetha Mathiyalakan	Location:	Proposed building - eastern side
Ground Surface El:	213.5 feet (see remark 1)	Total Depth:	17 feet
Groundwater Depth:	Not encountered	Drill Rig Type:	Morooka D-50 Rubber Tire ATV
		Drilling Method:	2-1/4" HSA
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Safety	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0 - 2	S1	4	5	5	8	24	15		Topsoil/ Fill ~2.2'	S1 - Top 4": Topsoil Mid. 2": Poorly Graded SAND with Silt (SP-SM), fine to medium, ~10% fines, bright brown, moist (subsoil)
	2 - 4	S2	9	12	15	16	24	6		Sand	Bot. 9": Poorly Graded SAND with Silt (SP-SM), fine to medium, 5-10% fines, tan-brown, moist (fill) S2 - Top 3": Poorly Graded SAND (SP), fine to medium, ~5% fines, brown-tan, moist (fill)
5ft											
	5 - 7	S3	5	8	11	12	24	13			Bot. 3": Poorly Graded SAND (SP), mostly medium, 5-10% coarse, <5% fines, tan, moist S3 - Poorly Graded SAND (SP), mostly medium, 5-10% coarse, <5% fines, ~1.5" coarse, subangular gravel piece near the bottom of the sample, tan, moist
10ft											
	10 - 12	S4	7	9	8	10	24	0			S4 - No Recovery (auger cuttings similar to S3)
15ft											
	15 - 17	S5	5	6	7	9	24	14			S5 - Poorly Graded SAND (SP), mostly medium, ~10% coarse, <5% fines, <5% coarse gravel, tan, moist
20ft											End of boring at 17 feet. Backfilled with drill cuttings.

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	New Hampshire Boring	Date Started:	8/18/2014
Drilling Foreman:	Ernie Nadeau	Date Completed:	8/18/2014
LGCI Engineer:	Zach Morris	Location:	Proposed building - SE corner
Ground Surface El:	214.5 feet (see remark 1)	Total Depth:	17 feet
Groundwater Depth:	Not encountered	Drill Rig Type:	Morooka D-50 Rubber Tire ATV
		Drilling Method:	2-1/4" HSA
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Safety	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0 - 2	S1	3	19	26	33	24	12		Topsoil/ Subsoil	S1 - Top 2": Topsoil Bot. 10": Silty SAND (SM), fine to medium, 15-20% fines, ~5% fine gravel, ~5% roots, brown, moist (subsoil)
	2 - 4	S2	23	16	17	20	24	16		Fill	S2 - Silty SAND (SM), fine to medium, ~20% fines, 5-10% organics, dark brown, moist (fill) S3 - Silty SAND with Gravel (SM), fine to medium, ~20% fines, ~15% mostly fine gravel, dark brown, moist (fill)
5ft											
	5 - 6.3	S3	8	33	60/4"		16	11		~6'	
										Sand	(trace of natural bright brown silty sand at the tip of the spoon)
10ft											
	10 - 12	S4	11	17	14	11	24	13			S4 - Poorly Graded SAND (SP), fine to medium, 5% fines, ~5% fine gravel, tan, moist
15ft											
	15 - 17	S5	10	15	18	43	24	11			S5 - Similar to S4, 5-10% fine gravel, tan, moist
20ft											End of boring at 17 feet. Backfilled with drill cuttings.

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	New Hampshire Boring	Date Started:	8/18/2014
Drilling Foreman:	Ernie Nadeau	Date Completed:	8/18/2014
LGCI Engineer:	Zach Morris	Location:	Proposed building - NE corner
Ground Surface El:	210 feet (see remark 1)	Total Depth:	17 feet
Groundwater Depth:	Not encountered	Drill Rig Type:	Morooka D-50 Rubber Tire ATV
		Drilling Method:	2-1/4" HSA
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Safety	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0 - 2	S1	6	7	10	15	24	16		Fill ~1'	S1 - Top 12": Poorly Graded SAND (SP), fine to medium, 5% fines, ~5% fine gravel, brown-tan, moist (fill)
											Bot. 4": Similar to top 12", tan, moist
	2 - 4	S2	25	35	21	18	24	9		Sand	S2 - Poorly Graded SAND (SP), fine to medium, <5% fines, tan, moist
5ft											
	5 - 7	S3	7	10	8	10	24	13			S3 - Similar to S2
10ft											
	10 - 12	S4	7	13	13	15	24	11			S4 - Similar to S2
15ft											
	15 - 17	S5	8	17	19	12	24	11			S5 - Poorly Graded SAND (SP), fine to medium, <5% fines, 5-10% fine gravel, tan, moist
20ft											End of boring at 17 feet. Backfilled with drill cuttings.

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	New Hampshire Boring	Date Started:	8/15/2014
Drilling Foreman:	Ernie Nadeau	Date Completed:	8/15/2014
LGCI Engineer:	Geetha Mathiyalakan	Location:	Proposed parking - NW side
Ground Surface El:	216 feet (see remark 1)	Total Depth:	17 feet
Groundwater Depth:	Wet samples below 5 feet	Drill Rig Type:	Morooka D-50 Rubber Tire ATV
		Drilling Method:	2-1/4" HSA
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Safety	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0 - 2	S1	6	17	23	21	24	19		Topsoil/ Subsoil ~1.2'	S1 - Top 4": Topsoil Mid 10": Silty SAND (SM), fine to medium, 10-15% fines, ~5% fine gravel, ~5% organics, dark brown, moist (subsoil)
5ft	5 - 7	S2	13	22	21	29	24	9		Fill	Bot. 5": Poorly Graded SAND (SP), mostly fine to medium, ~5% fines, tan-brown, moist (fill) S2 - Top 1": Silty SAND (SM), fine to medium, ~15% fines, 5-10% organics, ~5% roots, brown, wet (fill) Bot. 8": Poorly Graded SAND (SP), mostly medium, ~10% coarse, <5% fines, tan, wet (fill)
10ft	12 - 14	S3	6	12	14	19	24	16		~13.3'	S3 - Top 4": Poorly Graded SAND (SP), fine to medium, ~5% fines, tan, wet (fill) Mid. 11": Silty SAND (SM), mostly fine, 20-25% fines, ~10% organics with thin (~2") layer of wood chips, ~5% small roots, brown-gray, wet (fill)
15ft	15 - 17	S4	11	19	19	34	24	5		Sand	Bot. 1": Silty SAND (SM), fine to coarse, 15-20% fines, gray-reddish brown, wet S5 - Poorly Graded SAND with Silt (SP-SM), mostly fine to medium, ~10% fines, gray-brown, wet
20ft											End of boring at 17 feet. Backfilled with drill cuttings.

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	New Hampshire Boring	Date Started:	8/15/2014
Drilling Foreman:	Ernie Nadeau	Date Completed:	8/15/2014
LGCI Engineer:	Geetha Mathiyalakan	Location:	Proposed parking - northern side
Ground Surface El:	217 feet (see remark 1)	Total Depth:	11 feet
Groundwater Depth:	Not encountered	Drill Rig Type:	Morooka D-50 Rubber Tire ATV
		Drilling Method:	2-1/4" HSA
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Safety	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0 - 2	S1	8	10	18	17	24	8		Topsoil	S1 - Top 4": Topsoil
										Fill	Bot. 4": Poorly Graded SAND with Silt and Gravel (SP-SM), fine to medium, 5-10% fines, 10-15% mostly coarse, sub-angular gravel, brown-tan, moist (fill)
									2	~4'	
5ft	4 - 6	S2	14	18	19	16	24	2		Sand	S2 - ~1" - 1.5" coarse, angular gravel pieces (observed fine to medium sand, <5% fines, tan, moist auger cuttings below 4 feet)
10ft	9 - 11	S3	6	9	9	8	24	9			S3 - Poorly Graded SAND (SP), fine to medium, ~5% fines, <5% fine gravel, tan, moist
											End of boring at 11 feet. Backfilled with drill cuttings.
15ft											
20ft											

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.
2 - Estimated strata change based on the drilling condition.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	New Hampshire Boring	Date Started:	8/18/2014
Drilling Foreman:	Ernie Nadeau	Date Completed:	8/18/2014
LGCI Engineer:	Zach Morris	Location:	Proposed half-time building
Ground Surface El:	211 feet (see remark 1)	Total Depth:	22 feet
Groundwater Depth:	Not encountered	Drill Rig Type:	Morooka D-50 Rubber Tire ATV
		Drilling Method:	2-1/4" HSA
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Safety	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0.5-2.5	S1	5	25	26	26	24	11		Asphalt / Fill	~4.5" asphalt S1 - Poorly Graded SAND (SP), fine to medium, ~5% fines, ~5% fine gravel, bright brown to tan, moist (appears natural near the bottom half)
	2.5-4.5	S2	19	22	23	21	24	13		Sand	S2 - Poorly Graded SAND (SP), fine to medium, <5% fines, tan, moist
5ft											
	5 - 7	S3	11	12	15	13	24	12			S3 - Similar to S2
10ft											
	10 - 12	S4	6	10	13	17	24	14			S4 - Similar to S2
15ft											
	15 - 17	S5	11	20	24	31	24	12			S5 - Poorly Graded SAND (SP), fine to medium, <5% fines, 5-10% fine gravel, tan, moist
20ft											
	20 - 22	S6	50	25	25	44	24	16			S6 - Poorly Graded SAND (SP), mostly medium, <5% fines, tan, moist
											End of boring at 22 feet. Backfilled with drill cuttings.

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	New Hampshire Boring	Date Started:	8/18/2014
Drilling Foreman:	Ernie Nadeau	Date Completed:	8/18/2014
LGCI Engineer:	Zach Morris	Location:	Proposed Half-Time building
Ground Surface El:		Total Depth:	
Groundwater Depth:		Drill Rig Type:	Morooka D-50 Rubber Tire ATV
		Drilling Method:	2-1/4" HSA
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Safety	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
											B-115 was close to existing portion of half-time building, and was not drilled.
5ft											
10ft											
15ft											
20ft											

Remarks:

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	New Hampshire Boring	Date Started:	8/18/2014
Drilling Foreman:	Ernie Nadeau	Date Completed:	8/18/2014
LGCI Engineer:	Zach Morris	Location:	Proposed WWTP - SW corner
Ground Surface El:	214 feet (see remark 1)	Total Depth:	17 feet
Groundwater Depth:	Not encountered	Drill Rig Type:	Morooka D-50 Rubber Tire ATV
		Drilling Method:	2-1/4" HSA
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Safety	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0 - 2	S1	7	26	39	36	24	17		Topsoil ~1'	S1 - Top 12": Topsoil
	2 - 4	S2	22	21	17	20	24	11		Fill	Bot. 5": Poorly Graded SAND with Silt (SP-SM), fine to medium, 5-10% fines, brown, moist (fill) S2 - Silty SAND (SM), fine to medium, ~20% fines, 5-10% organics, ~5% small roots, black-brown, moist (fill)
5ft	5 - 7	S3	12	28	24	19	24	12			S3 - Silty SAND (SM), fine to medium, ~25% fines, ~5% fine gravel, <5% organics, <5% roots, brown, moist (fill)
10ft	10 - 12	S4	8	15	17	20	24	22		~11'	S4 - Top 12": Buried Topsoil
										Sand	Bot. 10": Poorly Graded SAND (SP), fine to medium, <5% fines, <5% fine gravel, tan, moist
15ft	15 - 17	S5	6	6	6	6	24	14			S5 - Poorly Graded SAND (SP), mostly medium, <5% fines, tan, moist
20ft											End of boring at 17 feet. Backfilled with drill cuttings.

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	New Hampshire Boring	Date Started:	8/18/2014
Drilling Foreman:	Ernie Nadeau	Date Completed:	8/18/2014
LGCI Engineer:	Zach Morris	Location:	Proposed WWTP - NE corner
Ground Surface El:	214 feet (see remark 1)	Total Depth:	22 feet
Groundwater Depth:	Not encountered	Drill Rig Type:	Morooka D-50 Rubber Tire ATV
		Drilling Method:	2-1/4" HSA
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Safety	Rock Core Barrel Size:	N/A
Drop:	30 inches		

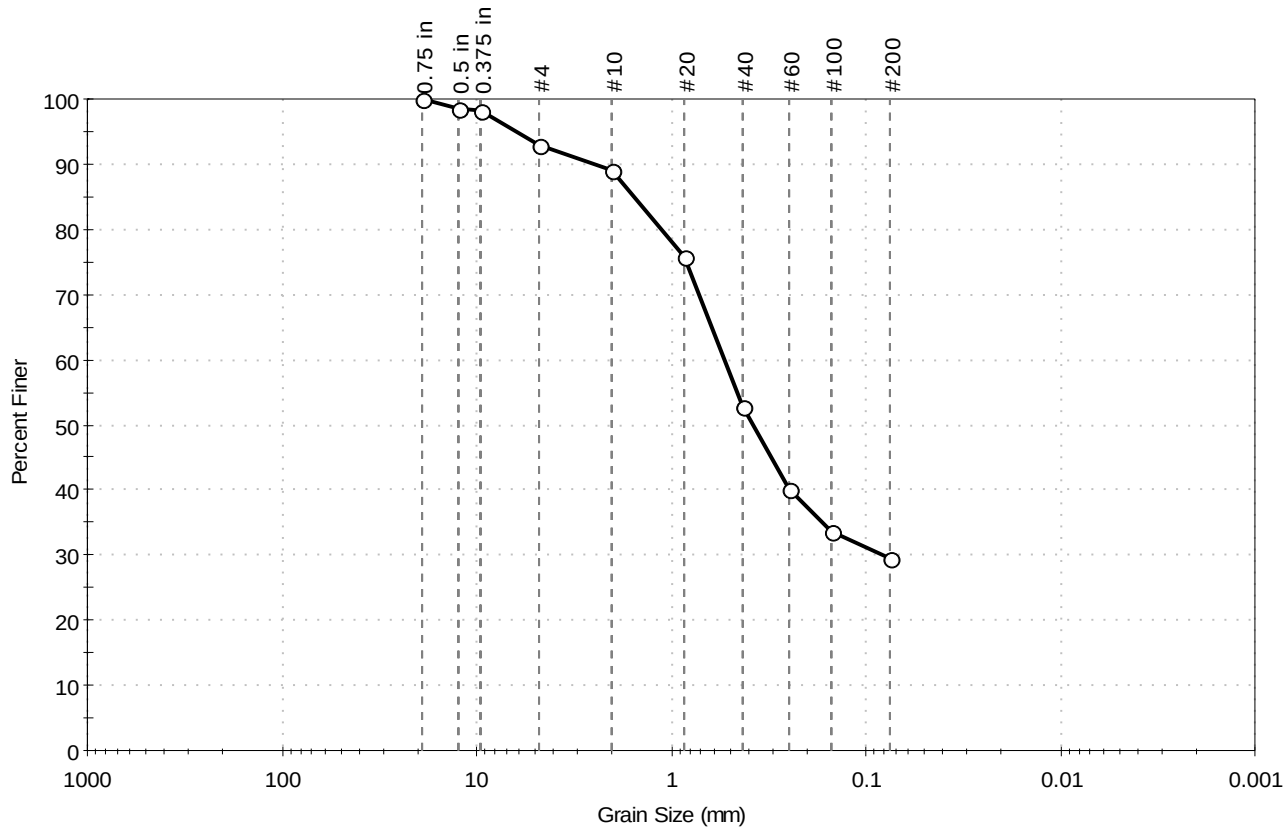
Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0 - 2	S1	5	22	24	21	24	13		Topsoil/ Subsoil	S1 - Top 4": Topsoil Bot. 9": Silty SAND (SM), fine to medium, ~25% fines, 5-10% fine gravel, 10-15% organics, ~5% roots, brown, moist (subsoil)
	2 - 4	S2	14	25	21	29	24	16		Fill	S2 - Silty SAND (SM), fine to medium, ~25% fines, 5-10% fine gravel, 10-15% organics, ~5% small roots, black-brown, moist (fill)
5ft											
	5 - 7	S3	15	23	29	16	24	12			S3 - Silty SAND (SM), fine to medium, ~20% fines, ~10% organics, <5% roots, black-brown, moist (fill)
	7 - 8.8	S4	19	50	54	60/5"	23	15		~7.8'	S4 - Top 9": Similar to S3 Bot. 6": Poorly Graded SAND (SP), fine to medium, ~5% fines, 5-10% fine gravel, tan, moist
10ft										Sand	
	10 - 12	S5	8	18	15	17	24	10			S5 - Poorly Graded SAND with Silt (SP-SM), mostly fine, 5-10% fines, ~5% fine gravel, tan, moist
15ft											S6 - Poorly Graded SAND (SP), fine to medium, <5% fines, ~5% fine gravel, tan, moist
	15 - 17	S6	5	8	11	9	24	8			
20ft											S7 - Similar to S6
	20 - 22	S7	7	14	13	17	24	10			
											End of boring at 22 feet. Backfilled with drill cuttings.

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

Appendix C Laboratory Test Results

Client:	Lahlaf Geotechnical Consulting				
Project:	Proposed Plymouth South High School				
Location:	Plymouth, MA			Project No:	GTX-301642
Boring ID:	B-2	Sample Type:	jar	Tested By:	jbr
Sample ID:	B-2-S1-2'-4'-Bot 8"	Test Date:	04/14/14	Checked By:	jdt
Depth :	2-4 ft	Test Id:	292743		
Test Comment:	---				
Sample Description:	Moist, dark brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	7.1	63.3	29.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	99		
0.375 in	9.50	98		
#4	4.75	93		
#10	2.00	89		
#20	0.85	76		
#40	0.42	53		
#60	0.25	40		
#100	0.15	34		
#200	0.075	30		

Coefficients

D_{85} = 1.5496 mm D_{30} = 0.0800 mm

D_{60} = 0.5296 mm D_{15} = N/A

D_{50} = 0.3789 mm D_{10} = N/A

C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample / Test Description

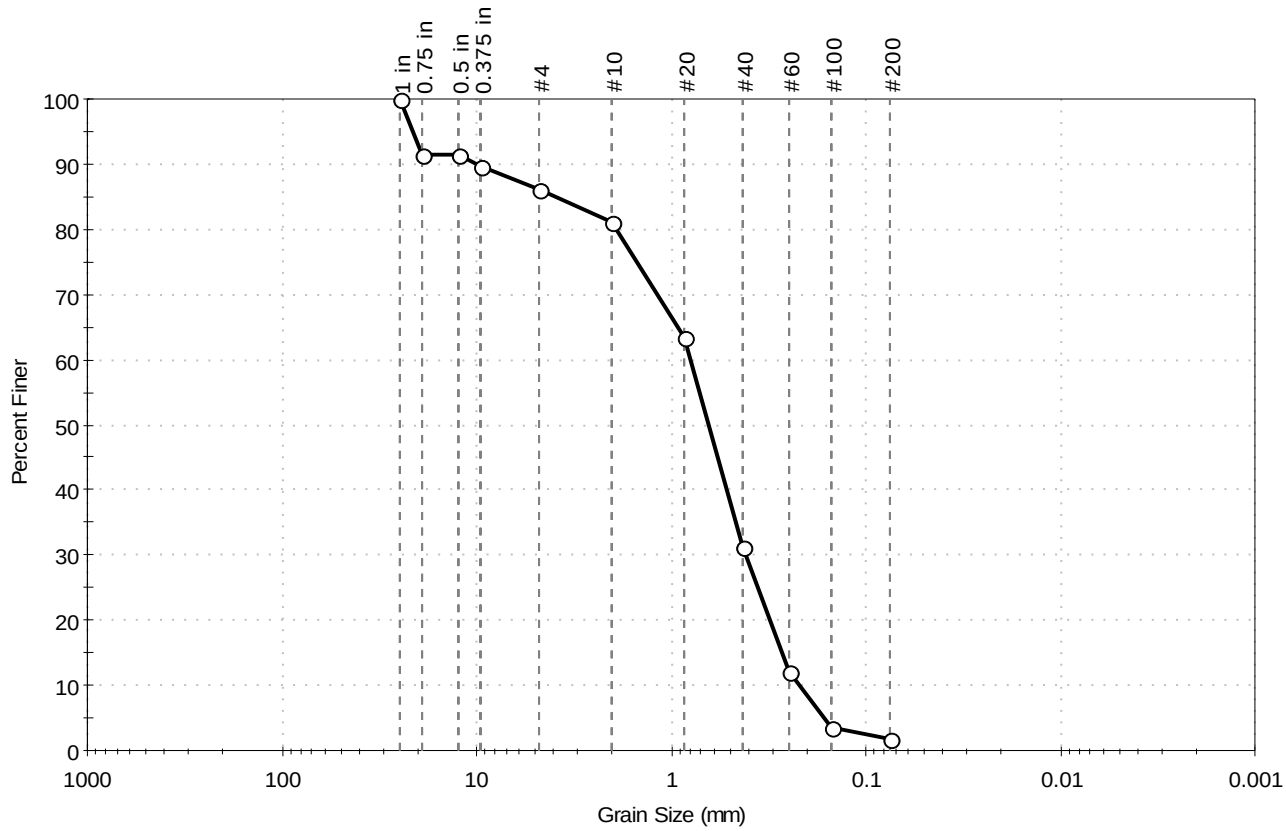
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

printed 4/15/2014 10:02:41 AM

Client:	Lahlaf Geotechnical Consulting				
Project:	Proposed Plymouth South High School				
Location:	Plymouth, MA			Project No:	GTX-301642
Boring ID:	B-3	Sample Type:	jar	Tested By:	jbr
Sample ID:	B-3-6'-8'	Test Date:	04/14/14	Checked By:	jdt
Depth :	6-8 ft	Test Id:	292744		
Test Comment:	---				
Sample Description:	Moist, brown sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	13.8	84.6	1.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	91		
0.5 in	12.50	91		
0.375 in	9.50	90		
#4	4.75	86		
#10	2.00	81		
#20	0.85	64		
#40	0.42	31		
#60	0.25	12		
#100	0.15	4		
#200	0.075	1.6		

Coefficients

D_{85} = 3.8777 mm	D_{30} = 0.4092 mm
D_{60} = 0.7877 mm	D_{15} = 0.2713 mm
D_{50} = 0.6349 mm	D_{10} = 0.2211 mm
C_u = 3.563	C_c = 0.961

Classification

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (1))

Sample / Test Description

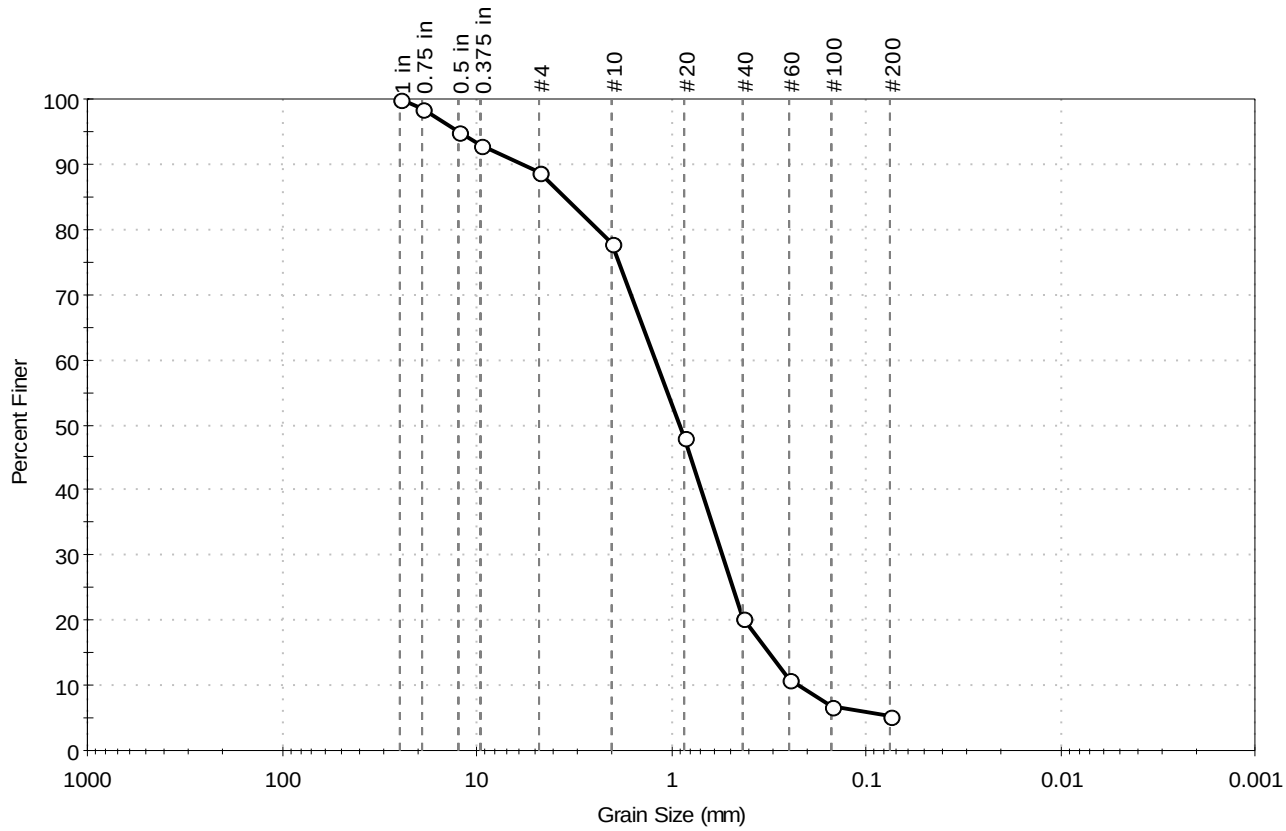
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

printed 4/15/2014 10:02:42 AM

Client:	Lahlaf Geotechnical Consulting				
Project:	Proposed Plymouth South High School				
Location:	Plymouth, MA			Project No:	GTX-301642
Boring ID:	TP-12	Sample Type:	jar	Tested By:	jbr
Sample ID:	TP-12-3'-8'	Test Date:	04/15/14	Checked By:	jdt
Depth :	3-8 ft	Test Id:	292745		
Test Comment:	---				
Sample Description:	Moist, brown sand with silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	11.3	83.4	5.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	99		
0.5 in	12.50	95		
0.375 in	9.50	93		
#4	4.75	89		
#10	2.00	78		
#20	0.85	48		
#40	0.42	20		
#60	0.25	11		
#100	0.15	7		
#200	0.075	5.3		

Coefficients

D_{85} = 3.5497 mm D_{30} = 0.5417 mm

D_{60} = 1.1992 mm D_{15} = 0.3149 mm

D_{50} = 0.8991 mm D_{10} = 0.2220 mm

C_u = 5.402 C_c = 1.102

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (1))

Sample / Test Description

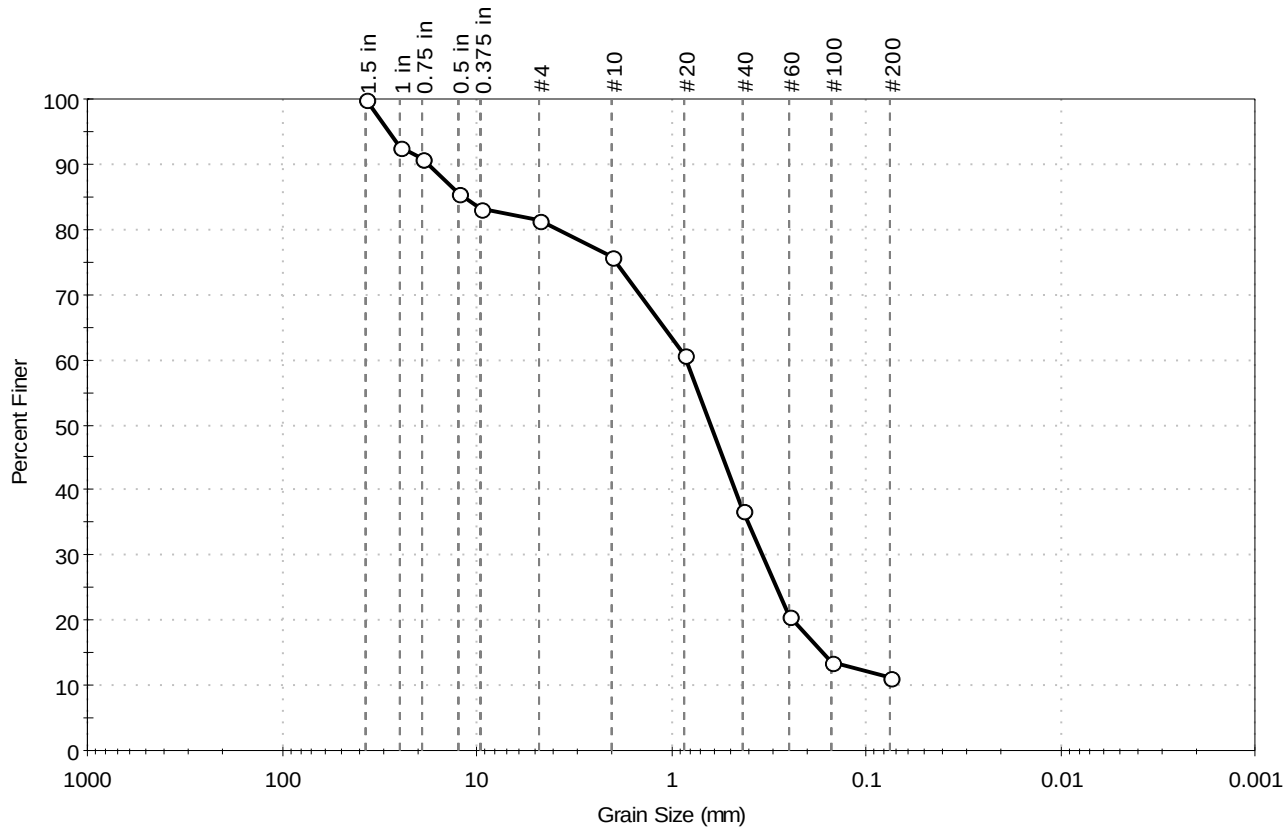
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

printed 4/15/2014 10:02:43 AM

Client:	Lahlaf Geotechnical Consulting				
Project:	Proposed Plymouth South High School				
Location:	Plymouth, MA			Project No:	GTX-301642
Boring ID:	TP-3	Sample Type:	jar	Tested By:	jbr
Sample ID:	TP-3-2'-4'	Test Date:	04/14/14	Checked By:	jdt
Depth :	2-4 ft	Test Id:	292740		
Test Comment:	---				
Sample Description:	Moist, brown sand with silt and gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	18.7	70.1	11.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	92		
0.75 in	19.00	91		
0.5 in	12.50	86		
0.375 in	9.50	83		
#4	4.75	81		
#10	2.00	76		
#20	0.85	61		
#40	0.42	37		
#60	0.25	21		
#100	0.15	14		
#200	0.075	11		

Coefficients

D_{85} = 11.6694 mm	D_{30} = 0.3397 mm
D_{60} = 0.8302 mm	D_{15} = 0.1664 mm
D_{50} = 0.6219 mm	D_{10} = 0.0536 mm
C_u = 15.489	C_c = 2.593

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample / Test Description

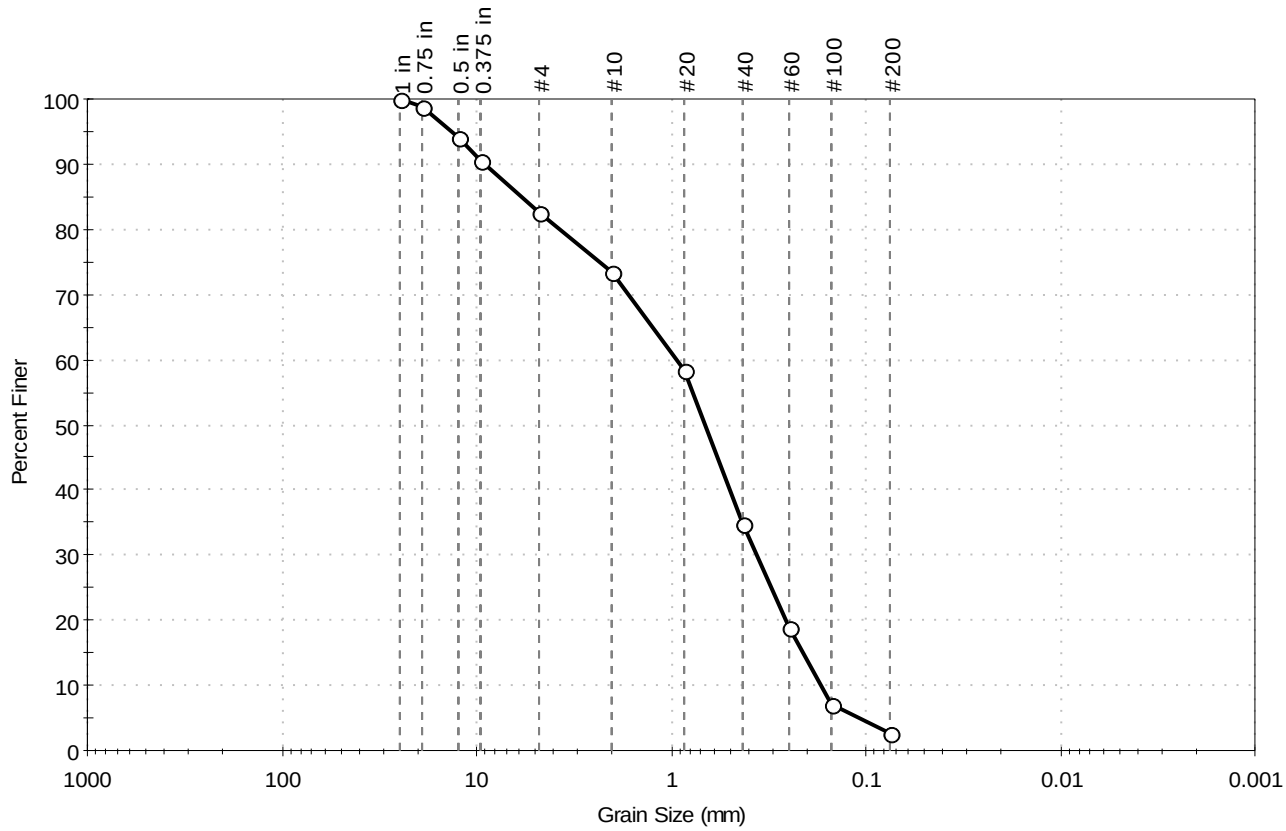
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

printed 4/15/2014 10:02:44 AM

Client:	Lahlaf Geotechnical Consulting				
Project:	Proposed Plymouth South High School				
Location:	Plymouth, MA			Project No:	GTX-301642
Boring ID:	TP-5	Sample Type:	jar	Tested By:	jbr
Sample ID:	TP-5-2'-4'	Test Date:	04/14/14	Checked By:	jdt
Depth :	2-4 ft	Test Id:	292741		
Test Comment:	---				
Sample Description:	Moist, brown sand with gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	17.3	80.2	2.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	99		
0.5 in	12.50	94		
0.375 in	9.50	91		
#4	4.75	83		
#10	2.00	73		
#20	0.85	58		
#40	0.42	35		
#60	0.25	19		
#100	0.15	7		
#200	0.075	2.5		

Coefficients

D_{85} = 5.8185 mm	D_{30} = 0.3624 mm
D_{60} = 0.9331 mm	D_{15} = 0.2113 mm
D_{50} = 0.6646 mm	D_{10} = 0.1698 mm
C_u = 5.495	C_c = 0.829

Classification

ASTM Poorly graded sand with gravel (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (1))

Sample / Test Description

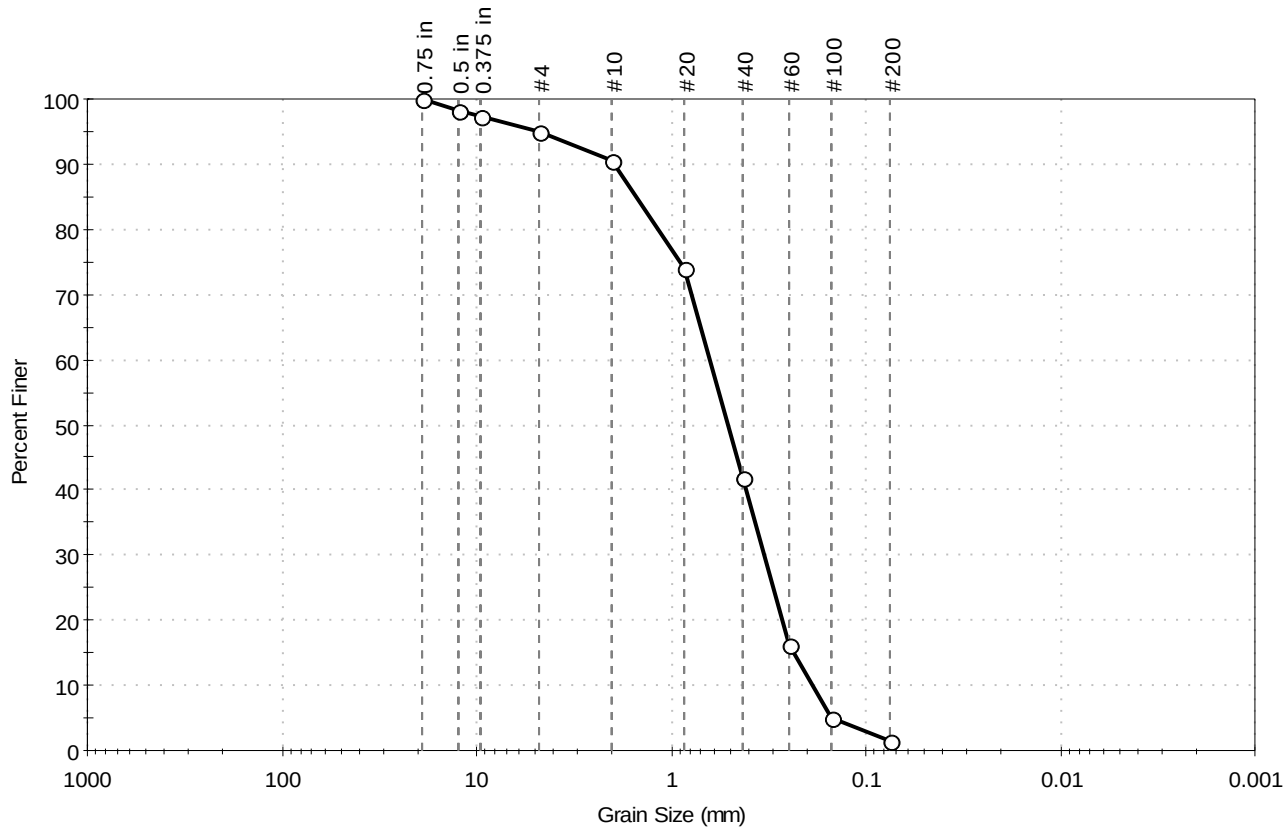
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

printed 4/15/2014 10:02:44 AM

Client:	Lahlaf Geotechnical Consulting				
Project:	Proposed Plymouth South High School				
Location:	Plymouth, MA			Project No:	GTX-301642
Boring ID:	TP-7	Sample Type:	jar	Tested By:	jbr
Sample ID:	TP-7-2'-4'	Test Date:	04/14/14	Checked By:	jdt
Depth :	2-4 ft	Test Id:	292742		
Test Comment:	---				
Sample Description:	Moist, brown sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	5.0	93.5	1.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	98		
0.375 in	9.50	97		
#4	4.75	95		
#10	2.00	91		
#20	0.85	74		
#40	0.42	42		
#60	0.25	16		
#100	0.15	5		
#200	0.075	1.5		

Coefficients

D_{85} = 1.4901 mm	D_{30} = 0.3327 mm
D_{60} = 0.6278 mm	D_{15} = 0.2363 mm
D_{50} = 0.5067 mm	D_{10} = 0.1884 mm
C_u = 3.332	C_c = 0.936

Classification

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (1))

Sample / Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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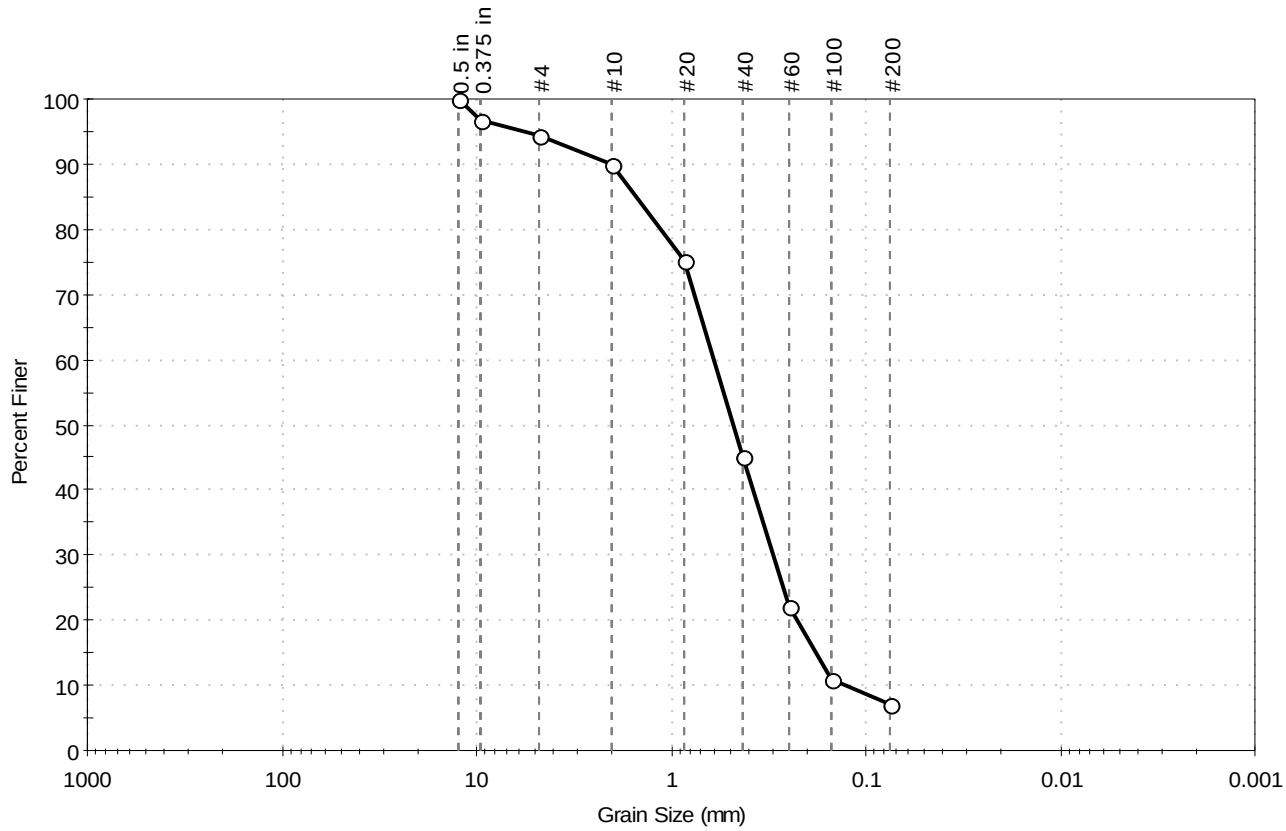
Client:	Lahlaf Geotechnical Consulting				
Project:	Proposed Plymouth South High School				
Location:	Plymouth, MA			Project No:	GTX-301642
Boring ID:	B-103	Sample Type:	jar	Tested By:	jbr
Sample ID:	B-103-S2-2'-4'	Test Date:	09/02/14	Checked By:	jdt
Depth :	2-4 ft	Test Id:	306857		
Test Comment:	---				
Sample Description:	Moist, olive sand with silt				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	5.7	87.3	7.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	97		
#4	4.75	94		
#10	2.00	90		
#20	0.85	75		
#40	0.42	45		
#60	0.25	22		
#100	0.15	11		
#200	0.075	7.0		

Coefficients

D_{85} = 1.4889 mm D_{30} = 0.2991 mm

D_{60} = 0.5974 mm D_{15} = 0.1808 mm

D_{50} = 0.4749 mm D_{10} = 0.1297 mm

C_u = 4.606 C_c = 1.155

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (1))

Sample / Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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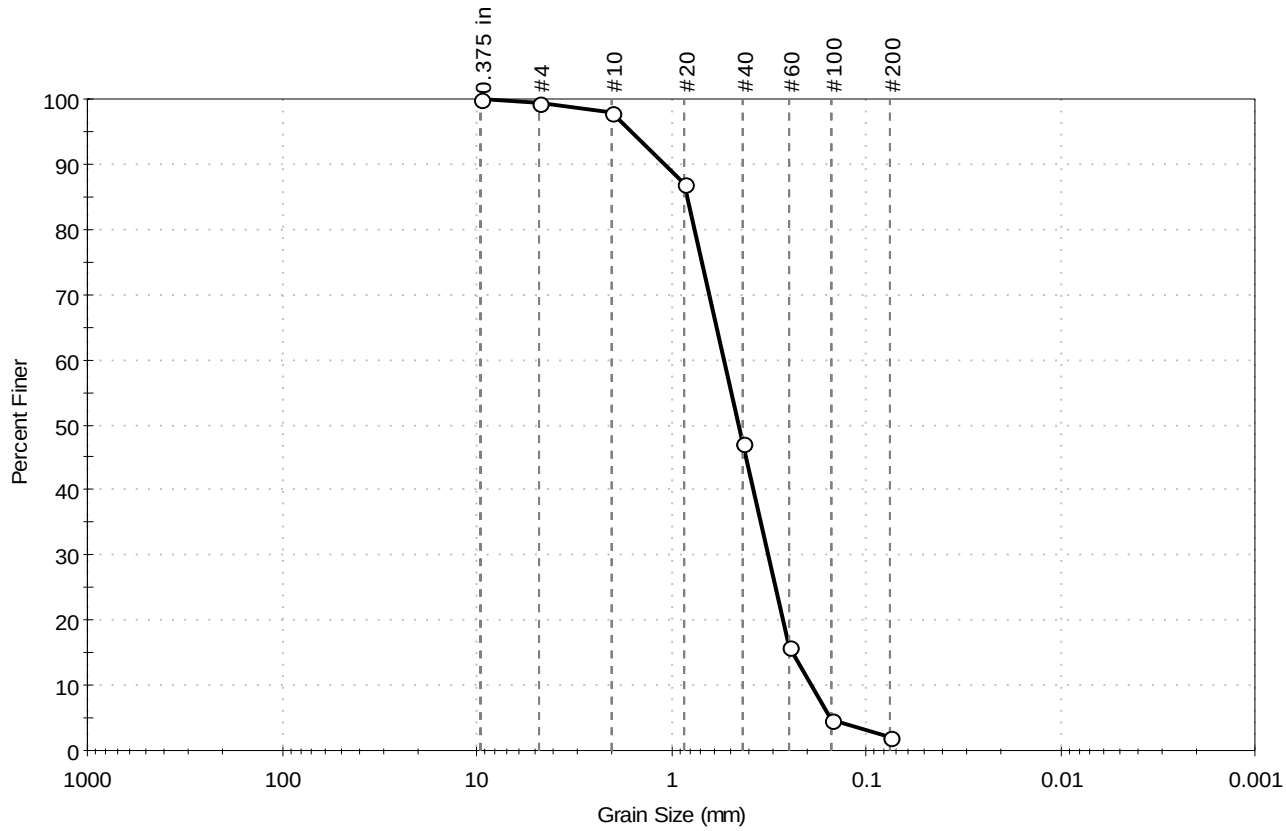
Client:	Lahlaf Geotechnical Consulting				
Project:	Proposed Plymouth South High School				
Location:	Plymouth, MA			Project No:	GTX-301642
Boring ID:	B-111	Sample Type:	jar	Tested By:	jbr
Sample ID:	B-111-S2-2'-4'	Test Date:	09/02/14	Checked By:	jdt
Depth :	2-4 ft	Test Id:	306858		
Test Comment:	---				
Sample Description:	Moist, light brown sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.6	97.3	2.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	98		
#20	0.85	87		
#40	0.42	47		
#60	0.25	16		
#100	0.15	5		
#200	0.075	2.1		

Coefficients

D_{85} = 0.8193 mm D_{30} = 0.3170 mm

D_{60} = 0.5306 mm D_{15} = 0.2387 mm

D_{50} = 0.4460 mm D_{10} = 0.1909 mm

C_u = 2.779 C_c = 0.992

Classification

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (1))

Sample / Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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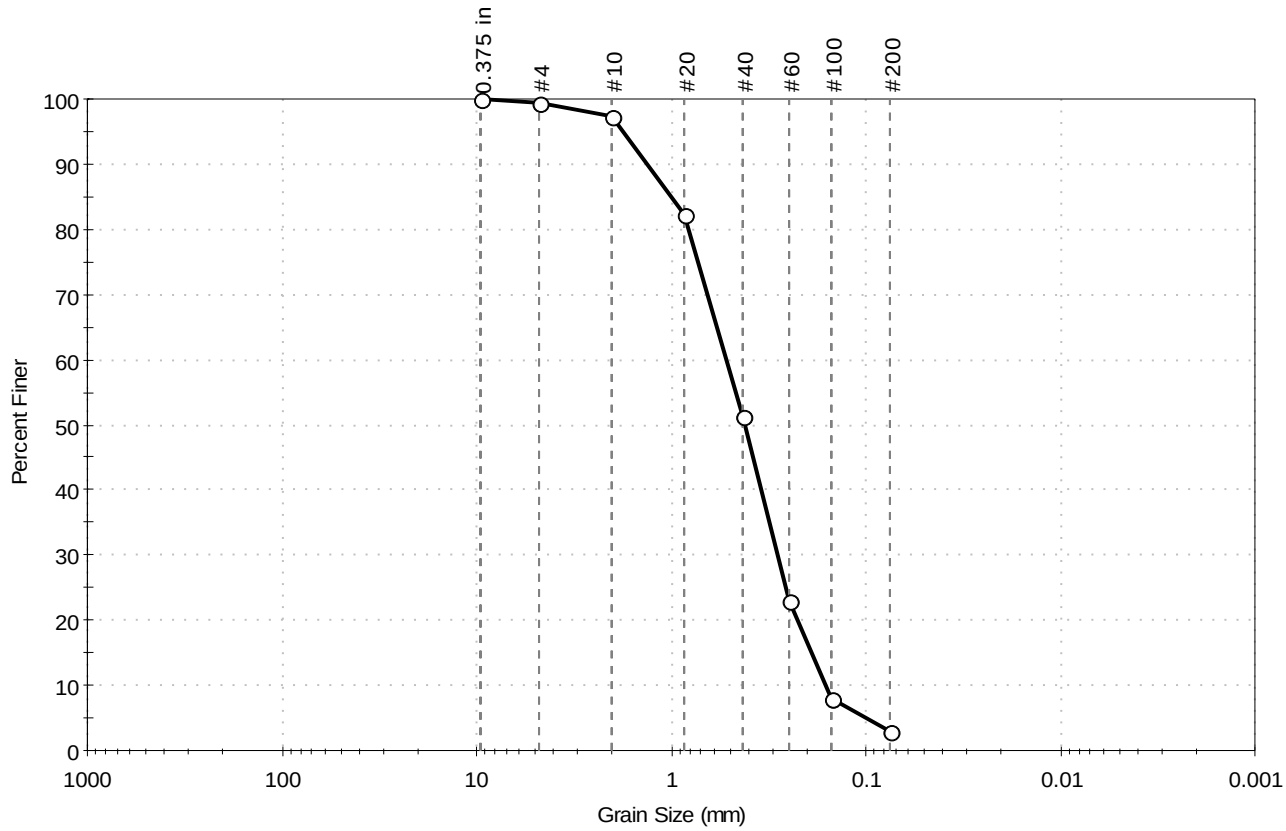
Client:	Lahlaf Geotechnical Consulting				
Project:	Proposed Plymouth South High School				
Location:	Plymouth, MA			Project No:	GTX-301642
Boring ID:	B-114	Sample Type:	jar	Tested By:	jbr
Sample ID:	B-114-S1-0.5'-2.5'	Test Date:	09/02/14	Checked By:	jdt
Depth :	0.5-2.5 ft	Test Id:	306859		
Test Comment:	---				
Sample Description:	Moist, light yellow sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.6	96.5	2.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	99		
#10	2.00	97		
#20	0.85	82		
#40	0.42	51		
#60	0.25	23		
#100	0.15	8		
#200	0.075	2.9		

Coefficients

D_{85} = 0.9930 mm D_{30} = 0.2856 mm

D_{60} = 0.5170 mm D_{15} = 0.1911 mm

D_{50} = 0.4154 mm D_{10} = 0.1612 mm

C_u = 3.207 C_c = 0.979

Classification

ASTM Poorly graded sand (SP)

AASHTO Fine Sand (A-3 (1))

Sample / Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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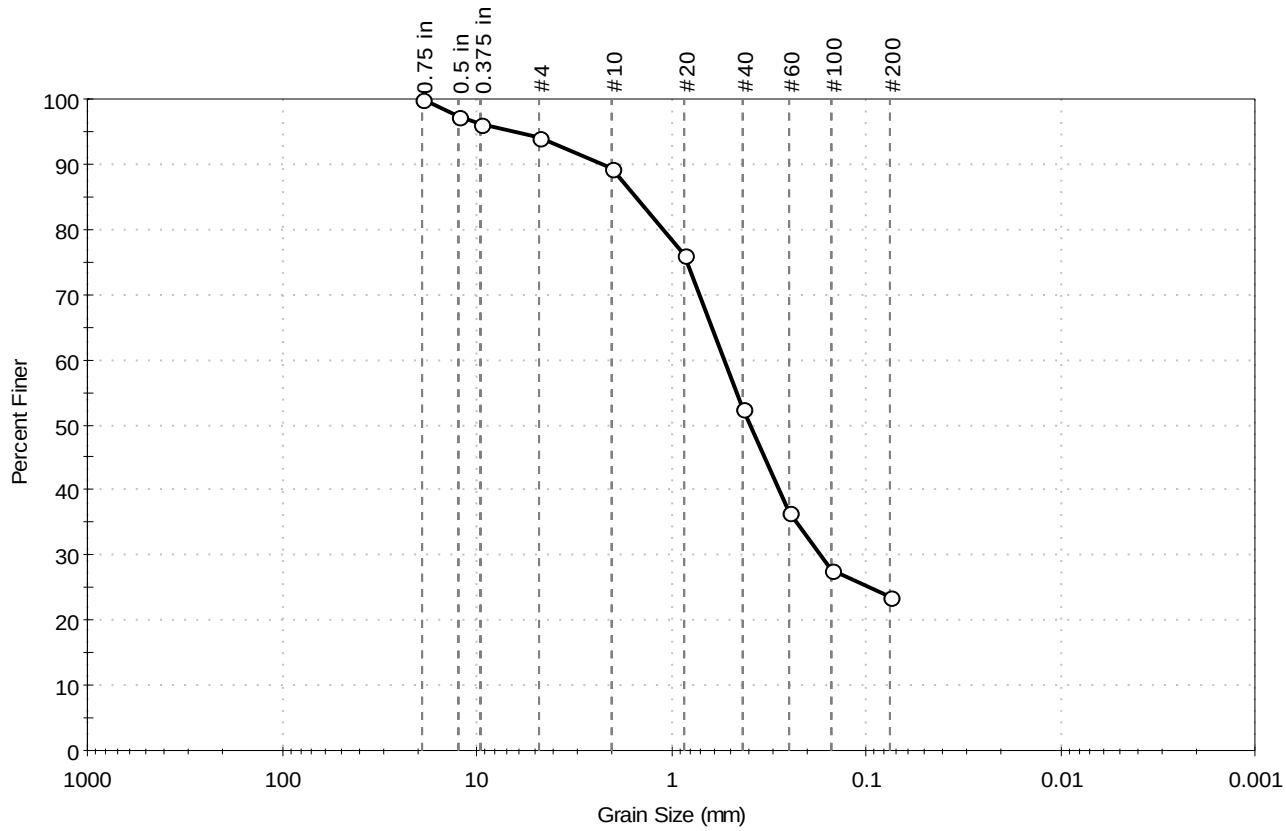
Client:	Lahlaf Geotechnical Consulting				
Project:	Proposed Plymouth South High School				
Location:	Plymouth, MA			Project No:	GTX-301642
Boring ID:	B-116	Sample Type:	jar	Tested By:	jbr
Sample ID:	B-116-S3-5'-7'	Test Date:	09/02/14	Checked By:	jdt
Depth :	5-7 ft	Test Id:	306860		
Test Comment:	---				
Sample Description:	Moist, grayish brown silty sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	5.8	70.6	23.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	97		
0.375 in	9.50	96		
#4	4.75	94		
#10	2.00	89		
#20	0.85	76		
#40	0.42	52		
#60	0.25	37		
#100	0.15	28		
#200	0.075	24		

Coefficients

D_{85} = 1.5111 mm D_{30} = 0.1701 mm

D_{60} = 0.5311 mm D_{15} = N/A

D_{50} = 0.3917 mm D_{10} = N/A

C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample / Test Description

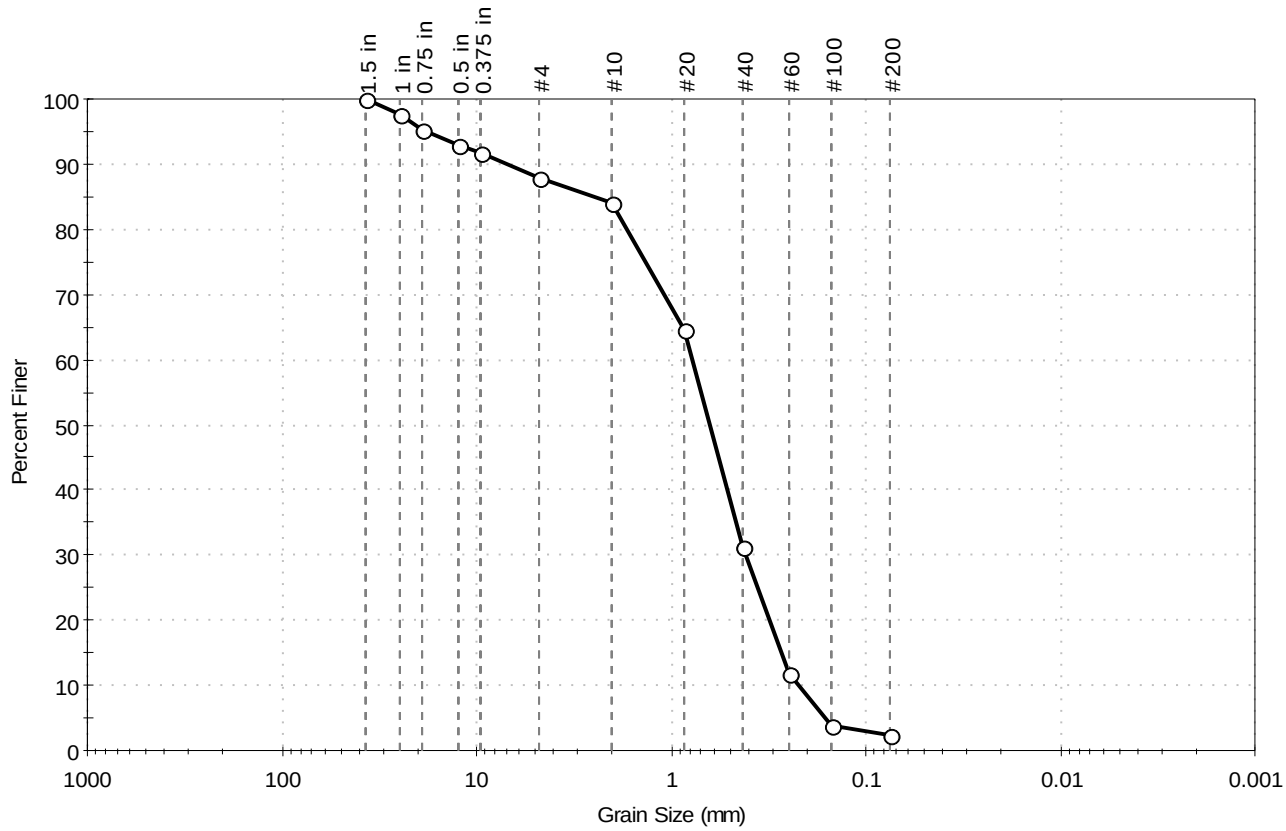
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

printed 9/3/2014 12:51:39 PM

Client:	Lahlaf Geotechnical Consulting				
Project:	Proposed Plymouth South High School				
Location:	Plymouth, MA			Project No:	GTX-301642
Boring ID:	TP-101	Sample Type:	bag	Tested By:	jbr
Sample ID:	TP-101-4'-5'	Test Date:	09/02/14	Checked By:	jdt
Depth :	4-5 ft	Test Id:	306853		
Test Comment:	---				
Sample Description:	Moist, light yellow sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	12.1	85.6	2.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	98		
0.75 in	19.00	95		
0.5 in	12.50	93		
0.375 in	9.50	92		
#4	4.75	88		
#10	2.00	84		
#20	0.85	65		
#40	0.42	31		
#60	0.25	12		
#100	0.15	4		
#200	0.075	2.3		

Coefficients

D_{85} = 2.4822 mm	D_{30} = 0.4110 mm
D_{60} = 0.7714 mm	D_{15} = 0.2726 mm
D_{50} = 0.6271 mm	D_{10} = 0.2220 mm
C_u = 3.475	C_c = 0.986

Classification

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (1))

Sample / Test Description

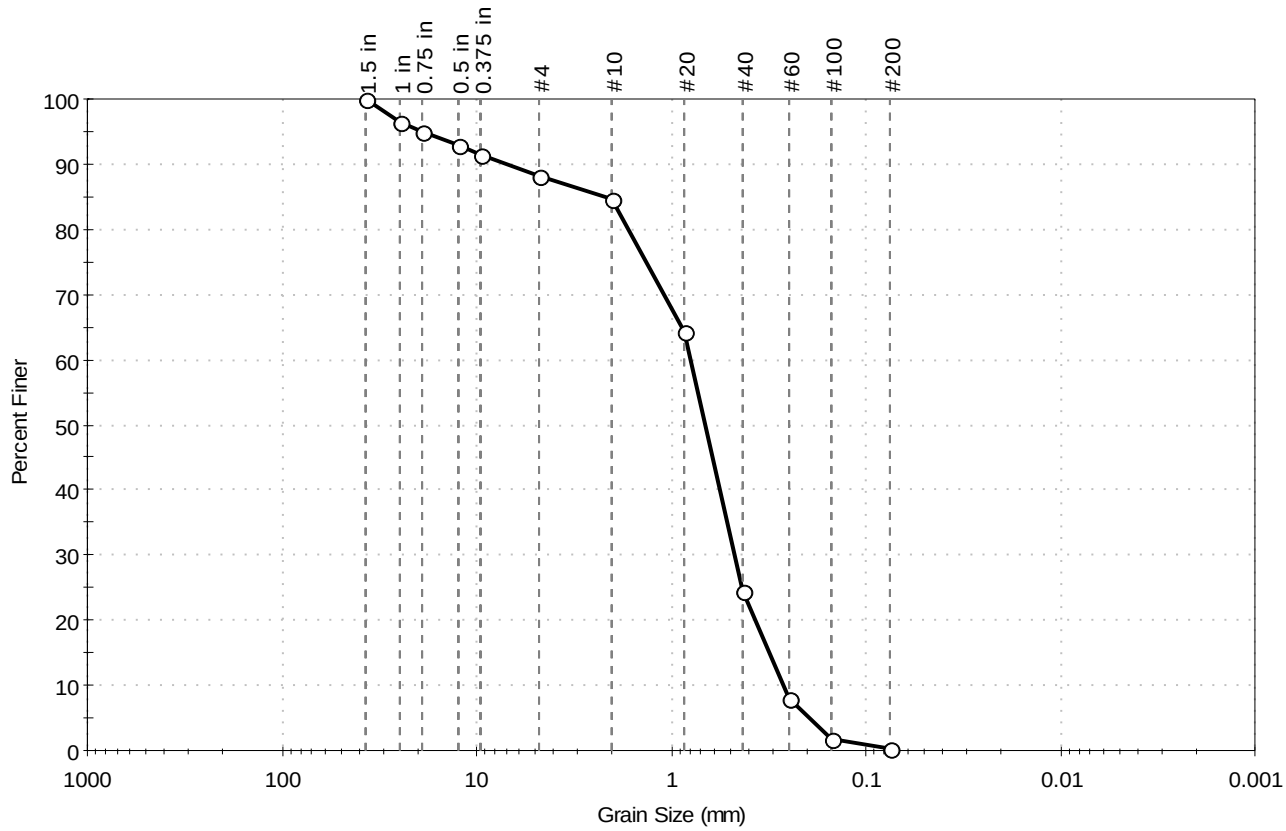
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

printed 9/3/2014 12:51:39 PM

Client:	Lahlaf Geotechnical Consulting				
Project:	Proposed Plymouth South High School				
Location:	Plymouth, MA			Project No:	GTX-301642
Boring ID:	TP-107	Sample Type:	bag	Tested By:	jbr
Sample ID:	TP-107-4'-5'	Test Date:	09/02/14	Checked By:	jdt
Depth :	4-5 ft	Test Id:	306855		
Test Comment:	---				
Sample Description:	Moist, light yellow sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	11.8	87.8	0.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	97		
0.75 in	19.00	95		
0.5 in	12.50	93		
0.375 in	9.50	92		
#4	4.75	88		
#10	2.00	85		
#20	0.85	64		
#40	0.42	24		
#60	0.25	8		
#100	0.15	2		
#200	0.075	0.4		

Coefficients

D_{85} = 2.2358 mm	D_{30} = 0.4679 mm
D_{60} = 0.7902 mm	D_{15} = 0.3135 mm
D_{50} = 0.6636 mm	D_{10} = 0.2671 mm
C_u = 2.958	C_c = 1.037

Classification

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (1))

Sample / Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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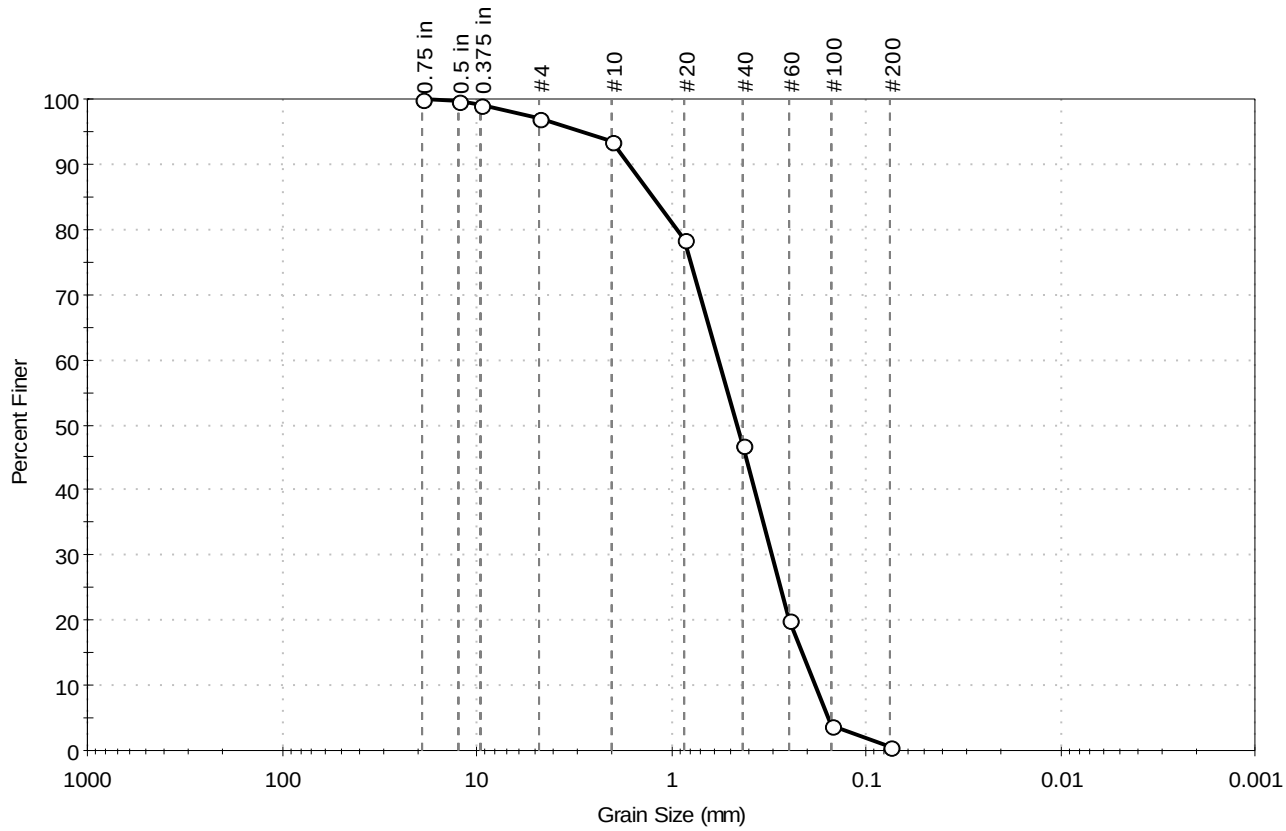
Client:	Lahlaf Geotechnical Consulting				
Project:	Proposed Plymouth South High School				
Location:	Plymouth, MA			Project No:	GTX-301642
Boring ID:	TP-109	Sample Type:	bag	Tested By:	jbr
Sample ID:	TP-109-4'-5'	Test Date:	09/02/14	Checked By:	jdt
Depth :	4-5 ft	Test Id:	306856		
Test Comment:	---				
Sample Description:	Moist, pale yellow sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	3.0	96.3	0.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	100		
0.375 in	9.50	99		
#4	4.75	97		
#10	2.00	94		
#20	0.85	78		
#40	0.42	47		
#60	0.25	20		
#100	0.15	4		
#200	0.075	0.7		

Coefficients

D_{85} = 1.2329 mm	D_{30} = 0.3042 mm
D_{60} = 0.5664 mm	D_{15} = 0.2132 mm
D_{50} = 0.4542 mm	D_{10} = 0.1820 mm
C_u = 3.112	C_c = 0.898

Classification

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (1))

Sample / Test Description

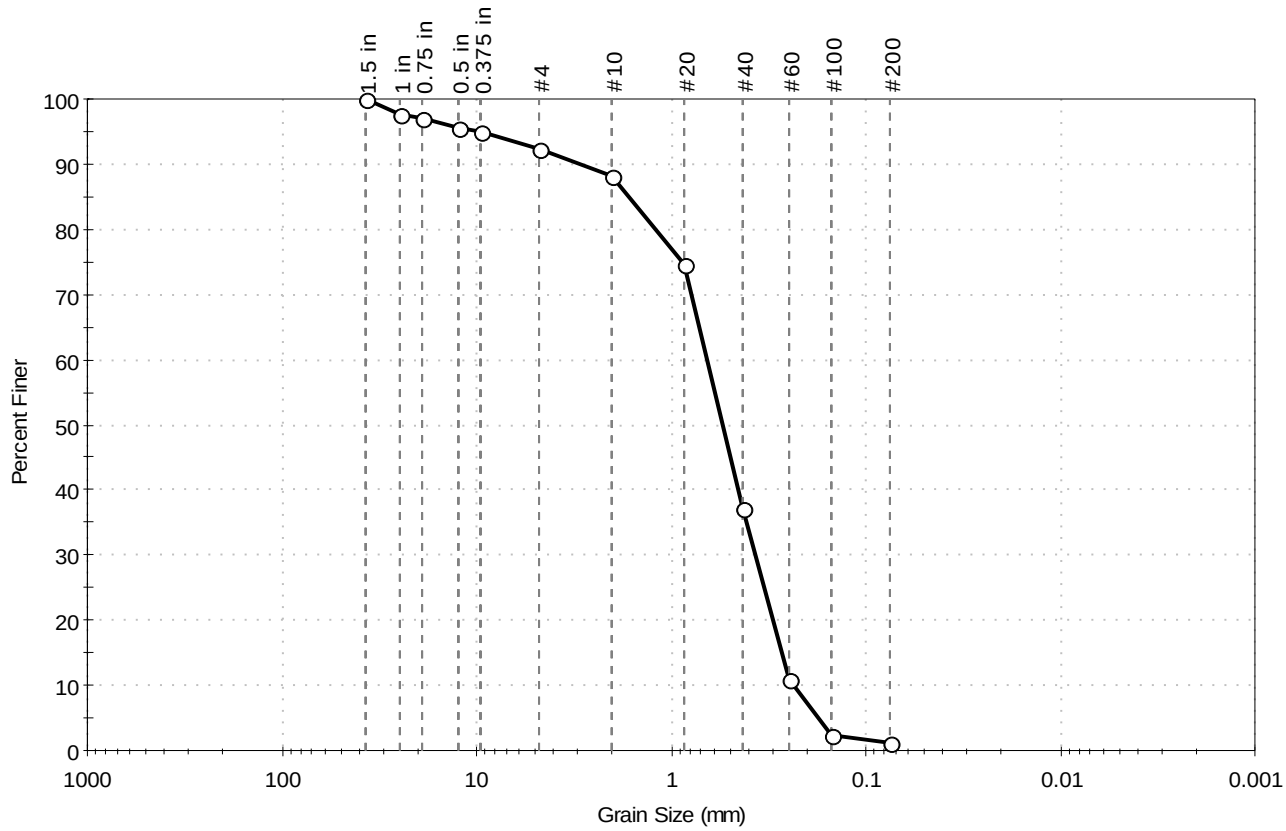
Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

printed 9/3/2014 12:51:40 PM

Client:	Lahlaf Geotechnical Consulting				
Project:	Proposed Plymouth South High School				
Location:	Plymouth, MA			Project No:	GTX-301642
Boring ID:	TP-112	Sample Type:	bag	Tested By:	jbr
Sample ID:	TP-112-4'-5'	Test Date:	09/02/14	Checked By:	jdt
Depth :	4-5 ft	Test Id:	306854		
Test Comment:	---				
Sample Description:	Moist, light yellow sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	7.7	91.1	1.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	98		
0.75 in	19.00	97		
0.5 in	12.50	95		
0.375 in	9.50	95		
#4	4.75	92		
#10	2.00	88		
#20	0.85	75		
#40	0.42	37		
#60	0.25	11		
#100	0.15	2		
#200	0.075	1.2		

Coefficients

D_{85} = 1.6369 mm	D_{30} = 0.3668 mm
D_{60} = 0.6469 mm	D_{15} = 0.2707 mm
D_{50} = 0.5377 mm	D_{10} = 0.2348 mm
C_u = 2.755	C_c = 0.886

Classification

ASTM Poorly graded sand (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-b (1))

Sample / Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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LGCI
Lahlaf Geotechnical Consulting, Inc.

May 4, 2015

Mr. L. Scott Dunlap, AIA
Ai3 Architects, LLC
526 Boston Post Road
Wayland, MA 01778
phone: (508) 358-0790
fax: (508) 358-0791

Re. Logs of additional Borings
Proposed Plymouth South High School
Plymouth, Massachusetts
LGCI Project No. 1408

Dear Mr. Dunlap:

Lahlaf Geotechnical Consulting, Inc. (LGCI) recently completed additional borings at the site of the proposed Plymouth South High School in Plymouth, Massachusetts. This letter contains the results of our additional borings. Our services were performed in general accordance with the scope and terms and conditions of our proposal No. 15019 dated April 10, 2015.

Subsurface Explorations

LGCI engaged Northern Drill Service of Northborough, Massachusetts to advance twelve (12) soil borings (B-201 to B-212) in the existing athletic fields on April 24 and 25, 2015 using a rubber-track mounted drill rig. The borings were advanced within the northern portion of the proposed building footprint. The purpose of the borings was to further explore the thickness of the existing fill and organic soil within the proposed building footprint.

The borings were advanced using 3-¼-inch hollow stem augers (HSAs) and extended to depths ranging between 10 and 23 feet beneath the ground surface.

The drillers performed Standard Penetration Tests (SPT) and obtained split spoon samples with an automatic hammer semi-continuously or at five-foot intervals as noted in the boring logs in general accordance with ASTM D-1586. Upon completion, the boreholes were backfilled the drill cuttings. Unless notified otherwise, we will dispose of the soil samples after three months.

The attached figure shows the locations of additional borings. The boring logs are attached to this letter.

Subsurface Conditions

The additional borings indicated a surficial layer of topsoil, overlying fill, overlying a buried layer of topsoil and subsoil, overlying natural sand. The borings were terminated in the natural sand. The depth to the bottom of the buried topsoil and subsoil ranged between 4.2 and 14 feet beneath

the ground surface. The depths to the bottom of the buried topsoil and subsoil, was generally consistent with those reported for the previous borings.

If you have any questions, please call us at (978) 330-5912.

Sincerely,

LAHLAF GEOTECHNICAL CONSULTING, INC.

Abdelmadjid M. Lahlaf, Ph.D., P.E.
Principal Engineer

Attachments: Figure 4A – Boring and Test Pit Location Plan (1 sheet)
Boring Logs (12 sheets)

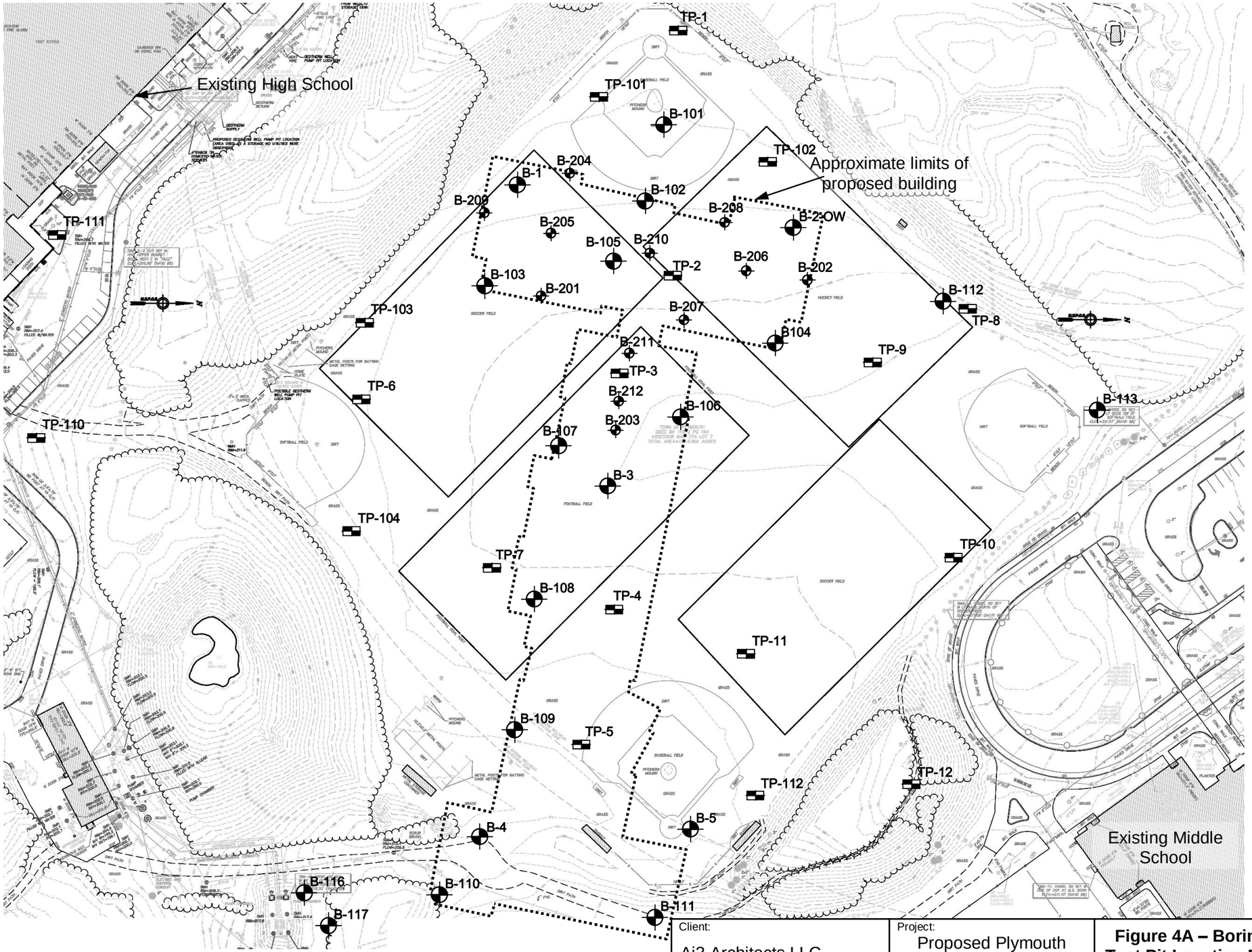
Note – Figure based on a survey plan provided to us by Pare Corporation (Pare) on April 22, 2014 and on a Plan titled "Overall Site Plan," prepared by Pare and dated July 2014.

Legend

Approximate location of boring. Borings B-1 to B-5 advanced by Northern Drill Service (NDS) of Northborough, MA between April 5 and 7, 2014. Borings B-101 to B-117 advanced by New Hampshire Boring of Brockton, MA between August 13 and 18, 2014. All borings were observed by Lahlaf Geotechnical Consulting, Inc. (LGCI).
OW denotes that a groundwater observation well was installed in the borehole.

Approximate location of boring advanced by NDS on April 24 and 25, 2015 and observed by LGCI.

Approximate location of test pit excavated by J. C. Engineering, Inc. of East Wareham, MA. TP-1 to TP-12 excavated on April 3 and 4, 2014. TP-101 to TP-112 excavated on August 11 and 12, 2014. All test pits were observed by LGCI.



Client:	Project:	Figure 4A – Boring and Test Pit Location Plan 1/2	
Ai3 Architects LLC	Proposed Plymouth South High School		
LGCI Lahlaf Geotechnical Consulting, Inc.	Project Location	LGCI Project No.	Date:
	Plymouth, MA	1408	May 2015

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	Northern Drill Service	Date Started:	04/25/2015
Drilling Foreman:	Tim Tucker	Date Completed:	04/25/2015
LGCI Engineer:	Alan Smith	Location:	Northern side of proposed building
Ground Surface El:	~ 214.5 ft (see remark 1)	Total Depth:	15 feet
Groundwater Depth:	Perched water table 5 ft	Drill Rig Type:	Mobile B-48 track mounted rig
		Drilling Method:	3 ¼" Hollow stem augers
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Automatic	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0.5-2.5	S1	3	8	13	12	24	22		Topsoil	Hand dug 6" of topsoil S1 - Top 1": Topsoil Bot. 21": Poorly Graded SAND (SP), fine to medium, ~5% fines, trace fine gravel, brown, moist (fill)
5ft	5 - 7	S2	3	6	7	9	24	18		Fill	S2: Poorly Graded SAND (SP), fine to medium, <5% fines, trace fine gravel, brown and gray, wet (fill)
	7 - 9	S3	13	17	15	18	24	24		8.5' Buried Topsoil	S3 - Top 18": Similar to S2 Bottom 6": Poorly Graded SAND with Silt (SP-SM), fine, trace medium, 10-15% fines with organics, gray, moist
10ft	9 - 11	S4	2	10	7	7	24	22		9.5'	S4 - Top 6": Similar to bottom of S3 Bottom 16": Poorly Graded SAND (SP), fine to medium, <5% fines, light brown, moist
	11 - 13	S5	4	10	14	19	24	18		Sand	S5: Similar to bottom of S4
15ft	13 - 15	S6	9	16	15	17	24	18			S6: Similar to bottom of S4
20ft											Bottom of boring at 15 ft, backfilled with auger cuttings

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	Northern Drill Service	Date Started:	04/24/2015
Drilling Foreman:	Tim Tucker	Date Completed:	04/24/2015
LGCI Engineer:	Alan Smith	Location:	Northern side of proposed building
Ground Surface El:	~ 215 ft (see remark 1)	Total Depth:	14 ft
Groundwater Depth:	Perched water table 2.5	Drill Rig Type:	Mobile B-48 track mounted rig
		Drilling Method:	3 ¼" Hollow stem augers
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Automatic	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0.5-2.5	S1	3	6	8	7	24	22		Topsoil	Hand dug 6" of topsoil
	2.5-4.5	S2	5	3	3	6	24	16		Fill	S1 - Top 3": Topsoil Bottom 19": Poorly Graded SAND (SP), fine to medium, ~5% fines, trace fine gravel, brown, moist (fill) S2: Similar to bottom of S1, except wet
5ft	4.5 - 6	S3	3	8	9		18	14			S3: Poorly Graded SAND (SP), fine to medium, trace coarse, <5% fines, brown, wet (fill)
	6 - 8	S4	17	11	14	13	24	22		7'	S4 - Top 12": Similar to S3
	8 - 10	S5	7	9	7	7	24	16		Buried Topsoil/ Subsoil	Bottom 10": Poorly Graded SAND with Silt (SP-SM), fine to medium, 10-15% organic fines, dark brown, moist S5 - Top 3": Similar to bottom of S4 Bottom 13": Poorly Graded SAND with Silt (SP-SM), fine to medium, ~10% fines, trace fine gravel, orange brown, moist
10ft	10 - 12	S6	3	3	3	4	24	18			S6: Similar to bottom of S5
	12 - 14	S7	4	8	7	9	24	16		12' Sand	S7: Poorly Graded SAND (SP), fine to medium, trace coarse, <5% fines, light brown, moist
15ft											Bottom of boring at 14 ft, backfilled with auger cuttings
20ft											

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	Northern Drill Service	Date Started:	04/25/2015
Drilling Foreman:	Tim Tucker	Date Completed:	04/25/2015
LGCI Engineer:	Alan Smith	Location:	Northern side of proposed building
Ground Surface El:	~ 215 ft (see remark 1)	Total Depth:	10 ft
Groundwater Depth:	Not encountered	Drill Rig Type:	Mobile B-48 track mounted rig
		Drilling Method:	3 ¼" Hollow stem augers
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Automatic	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0 - 2	S1	2	3	4	5	24	18		Topsoil	S1 - Top 6": Topsoil Bottom 12": Poorly Graded SAND (SP), fine to medium, ~5% fines, brown, moist (fill)
	2 - 4	S2	5	10	12	17	24	20		Fill 4'	S2: Similar to bottom of S1
5ft	4 - 6	S3	7	9	6	7	24	22		Topsoil 4.2'	S3 - Top 3": Poorly Graded SAND with Silt (SP-SM), fine to medium, 10-15% fines with organics, brown, moist
	6 - 8	S4	6	8	4	4	24	16		Sand	Bottom 19": Poorly Graded SAND (SP), fine to medium, ~5% fines, brown, moist S4: Poorly Graded SAND (SP), fine to medium, <5% fines, light brown, moist
	8 - 10	S5	4	10	9	11	24	16			S5: Similar to S4
10ft											Bottom of boring at 10 ft, backfilled with auger cuttings
15ft											
20ft											

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	Northern Drill Service	Date Started:	04/24/2015
Drilling Foreman:	Tim Tucker	Date Completed:	04/24/2015
LGCI Engineer:	Alan Smith	Location:	Northern side of proposed building
Ground Surface El:	~ 213.5 (see remark 1)	Total Depth:	23 ft
Groundwater Depth:	Not encountered	Drill Rig Type:	Mobile B-48 track mounted rig
		Drilling Method:	3 ¼" Hollow stem augers
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Automatic	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0.5-2.5	S1	3	4	7	13	24	16		Topsoil	Hand dug 6" of topsoil
										Fill	S1: Poorly Graded SAND (SP), fine to medium, <5% fines, 5-10% fine gravel, brown, moist (fill)
5ft	5 - 7	S2	5	9	11	11	24	15			S2: Similar to bottom of S1, except <5% fine gravel
10ft	10 - 12	S3	6	6	3	3	24	18		11.2'	S3 - Top 15": Similar to S1
	12 - 14	S4	3	3	4	4	24	16		Topsoil/ Subsoil	Bottom 3": Silty SAND (SM), fine, 15-20% organic fines, black, wet S4: Poorly Graded SAND with Silt (SP-SM), fine, trace medium, ~10% fines, orange brown, moist
15ft	14 - 16	S5	3	3	3	3	24	21		Sand	S5: Poorly Graded SAND (SP), fine, trace medium, <5% fines, brown, moist
	16 - 18	S6	9	10	13	13	24	12			S6: Poorly Graded SAND (SP), fine to medium, <5% fines, ~5% fine gravel, light brown, moist
20ft	19 - 21	S7	18	10	10	12	24	20			S7: Poorly Graded SAND (SP), fine to coarse, <5% fines, ~10% fine gravel, light brown, moist
	21 - 23	S8	12	13	11	15	24	16			S8: Similar to S7
											Bottom of boring at 23 ft, backfilled with auger cuttings

Remarks:
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BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	Northern Drill Service	Date Started:	04/24/2015
Drilling Foreman:	Tim Tucker	Date Completed:	04/24/2015
LGCI Engineer:	Alan Smith	Location:	Northern side of proposed building
Ground Surface El:	~ 214 ft (see remark 1)	Total Depth:	14 ft
Groundwater Depth:	Not encountered	Drill Rig Type:	Mobile B-48 track mounted rig
		Drilling Method:	3 ¼" Hollow stem augers
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Automatic	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0.5-2.5	S1	6	8	10	27	24	20		Topsoil	Hand dug 6" of topsoil S1 - Top 4": Topsoil Bottom 16": Poorly Graded SAND (SP), fine to medium, ~5% fines, brown, moist (fill)
5ft	5 - 7	S2	5	9	11	11	24	15		Fill	S2: Similar to bottom of S1
10ft	8 - 10	S3	8	8	4	5	24	22		9.3'	S3 - Top 16": Poorly Graded SAND with Silt (SP-SM), fine to medium, 10-15% fines, gray, moist (fill)
	10 - 12	S4	3	3	3	4	24	20		Topsoil/ Subsoil 11'	Bottom 6": Poorly Graded SAND with Silt (SP-SM), fine, 10-15% fines with organics, gray, moist, 1" layer of peat S4 - Top 12": Poorly Graded SAND with Silt (SP-SM), fine to medium, 10-15% fines, orange brown, moist
15ft	12 - 14	S5	3	2	4	9	24	14		Sand	Bottom 8": Poorly Graded SAND (SP), fine to medium, <5% fines, brown, moist S5: Similar to bottom of S4
20ft											Bottom of boring at 14 ft, backfilled with auger cuttings

Remarks:
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LGCI
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BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	Northern Drill Service	Date Started:	04/24/2015
Drilling Foreman:	Tim Tucker	Date Completed:	04/24/2015
LGCI Engineer:	Alan Smith	Location:	Northern side of proposed building
Ground Surface El:	~ 214.5 ft (see remark 1)	Total Depth:	14 ft
Groundwater Depth:	Perched water table 6 to 7.5 ft	Drill Rig Type:	Mobile B-48 track mounted rig
		Drilling Method:	3 ¼" Hollow stem augers
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Automatic	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0.5-2.5	S1	6	9	8	12	24	20		Topsoil	Hand dug 6" of topsoil
										Fill	S1 - Top 4": Topsoil Bottom 16": Poorly Graded SAND (SP), fine to medium, <5% fines, trace fine gravel, brown, moist (fill)
5ft	4 - 6	S2	6	10	14	15	24	20			S2: Similar to bottom of S1, except trace organic lenses
	6 - 8	S3	8	6	6	4	24	24			S3 - Top 18": Similar to bottom S1, except wet
										7.5'	
	8 - 10	S4	3	4	5	5	24	18		Topsoil/ Subsoil	Bottom 6": Poorly Graded SAND with Silt (SP-SM), fine, 10-15% fines with organics, dark brown, wet S4 - Top 12": Poorly Graded SAND with Silt (SP-SM), fine to medium, 10-15% fines, orange brown, moist
10ft										9'	
	10 - 12	S5	4	6	7	7	24	18		Sand	Bottom 6": Poorly Graded SAND (SP), fine to medium, trace coarse, ~5% fines, brown, moist S5: Similar to bottom of S4, except light brown
	12 - 14	S6	6	7	8	9	24	20			S6: Poorly Graded SAND (SP), fine, <5% fines, light brown, moist
15ft											Bottom of boring at 14 ft, backfilled with auger cuttings
20ft											

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

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BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	Northern Drill Service	Date Started:	04/25/2015
Drilling Foreman:	Tim Tucker	Date Completed:	04/25/2015
LGCI Engineer:	Alan Smith	Location:	Northern side of proposed building
Ground Surface El:	~ 215 ft (see remark 1)	Total Depth:	14 ft
Groundwater Depth:	Not encountered	Drill Rig Type:	Mobile B-48 track mounted rig
		Drilling Method:	3 ¼" Hollow stem augers
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Automatic	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0.5-2.5	S1	7	8	12	8	24	22		Topsoil	Hand dug 6" of topsoil S1 - Top 2": Topsoil Bottom 20": Poorly Graded SAND (SP), fine to medium, 5-10% fines, brown, moist (fill)
5ft	4 - 6	S2	5	8	10	12	24	20		Fill	S2: Poorly Graded SAND with Silt (SP-SM), fine to medium, 10-15% fines, gray and brown, moist
	6 - 8	S3	14	6	5	6	24	20		7'	S3 - Top 12": Similar to S2 Middle 1": Poorly Graded SAND with Silt (SP-SM), fine, 10-15% organic fines, black, moist
	8 - 10	S4	3	2	3	4	24	18		Topsoil/ Subsoil	Bottom 7": Poorly Graded SAND with Silt (SP-SM), fine, trace medium, 10-15% fines, orange brown, moist S4 - Top 12": Similar to bottom of S3
10ft	10 - 12	S5	3	5	8	10	24	14		9'	Bottom 6": Poorly Graded SAND (SP), fine to medium, <5% fines, brown, moist S5: Similar to bottom of S4
	12 - 14	S6	10	12	14	14	24	20		Sand	S6: Similar to bottom of S4, except trace gravel
15ft											Bottom of boring at 14 ft, backfilled with auger cuttings
20ft											

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
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BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	Northern Drill Service	Date Started:	04/24/2015
Drilling Foreman:	Tim Tucker	Date Completed:	04/24/2015
LGCI Engineer:	Alan Smith	Location:	Northern side of proposed building
Ground Surface El:	~ 214 ft (see remark 1)	Total Depth:	13 ft
Groundwater Depth:	Perched water table 5 to 9.5 ft	Drill Rig Type:	Mobile B-48 track mounted rig
		Drilling Method:	3 ¼" Hollow stem augers
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Automatic	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0.5-2.5	S1	5	9	9	10	24	22		Topsoil	Hand dug 6" of topsoil S1 - Top 6": Topsoil Bottom 16": Poorly Graded SAND (SP), fine to medium, ~5% fines, trace fine gravel, trace organics, brown, moist (fill)
5ft	5 - 7	S2	5	7	11	13	24	18		Fill	S2: Poorly Graded SAND (SP), fine to medium, trace coarse, ~5% fines, ~5% fine gravel, trace organics, brown, wet (fill)
	7 - 9	S3	10	15	16	16	24	24		8.5'	S3 - Top 18": Similar to S2
10ft	9 - 11	S4	3	6	6	6	24	16		Buried Topsoil/ Subsoil	Bottom 6": Poorly Graded SAND with Silt (SP-SM), fine to medium, 10-15% organic fines, dark brown, wet S4 - Top 6": Similar to bottom of S3
	11 - 13	S5	6	8	8	7	24	16		11' Sand	Bottom 10": Poorly Graded SAND with Silt (SP-SM), fine to medium, 10-15% fines, orange brown, moist S5: Poorly Graded SAND (SP), fine, trace medium, ~5% fines, trace gravel, brown, moist
15ft											Bottom of boring at 13 ft, backfilled with auger cuttings
20ft											

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	Northern Drill Service	Date Started:	04/25/2015
Drilling Foreman:	Tim Tucker	Date Completed:	04/25/2015
LGCI Engineer:	Alan Smith	Location:	Northern side of proposed building
Ground Surface El:	~ 213.5 ft (see remark 1)	Total Depth:	16 ft
Groundwater Depth:	Perched water table 8 to 9.2 ft	Drill Rig Type:	Mobile B-48 track mounted rig
		Drilling Method:	3 ¼" Hollow stem augers
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Automatic	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0.5-2.5	S1	4	9	10	13	24	22		Topsoil	Hand dug 6" of topsoil
										Fill	S1 - Top 6": Topsoil Bottom 16": Poorly Graded SAND (SP), fine to medium, ~5% fines, trace organics, brown, moist (fill)
5ft											
	5 - 7	S2	6	9	8	14	24	18			S2: Similar to bottom of S1
	8 - 10	S3	4	10	8	6	24	22		9.2'	S3 - Top 15": Similar to bottom of S1, except wet
10ft										Buried Topsoil	Bottom 7": Silty SAND (SM), fine, 15-20% organic fines, dark brown, wet
	10 - 12	S4	3	3	5	7	24	14			S4 - Top 10": Similar to bottom of S3 Bottom 4": Poorly Graded SAND with Silt (SP-SM), fine to medium, 10-15% fines, orange brown, moist
	12 - 14	S5	7	9	13	14	24	16		12'	S5: Poorly Graded SAND (SP), fine to medium, <5% fines, trace fine gravel, light brown, moist
										Sand	
15ft	14 - 16	S6	11	14	13	12	24	16			S6: Similar to S5
											Bottom of boring at 16 ft, backfilled with auger cuttings
20ft											

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**		LGCI Project No.: 1408
Drilling Subcontractor:	Northern Drill Service	Date Started:	04/24/2015
Drilling Foreman:	Tim Tucker	Date Completed:	04/24/2015
LGCI Engineer:	Alan Smith	Location:	Northern side of proposed building
Ground Surface El:	~ 214.5 (see remark 1)	Total Depth:	15 ft
Groundwater Depth:	Not encountered	Drill Rig Type:	Mobile B-48 track mounted rig
		Drilling Method:	3 ¼" Hollow stem augers
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Automatic	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0.5-2.5	S1	5	14	13	12	24	24		Topsoil	Hand dug 6" of topsoil
										Fill	S1 - Top 6": Topsoil Bottom 18": Poorly Graded SAND with Silt (SP-SM), fine to medium, ~10% fines, brown, moist (fill)
5ft											
	5 - 7	S2	7	23	28	18	24	14			S2: Poorly Graded SAND with Silt (SP-SM), fine to medium, trace coarse, 10-15% fines, trace fine gravel, gray, moist (fill)
	7 - 9	S3	22	21	16	13	24	18		8.5'	S3: Silty SAND (SM), fine, 15-20% fines, ~5% fine gravel, trace organics, gray, moist (fill), organics in spoon tip
10ft	9 - 11	S4	4	5	5	4	24	18		Buried Topsoil/ Subsoil	S4 - Top 3": Poorly Graded SAND with Silt (SP-SM), fine, 10-15% fines with organics, dark brown, moist Bottom 15": Poorly Graded SAND with Silt (SP-SM), fine to medium, 10-15% fines, orange brown, moist
	11 - 13	S5	3	2	3	5	24	20		11'	S5: Poorly Graded SAND with Silt (SP-SM), fine, 5-10% fines, brown, moist
	13 - 15	S6	3	5	7	6	24	16		Sand	S6: Poorly Graded SAND (SP), fine, <5% fines, light brown, moist
15ft											
											Bottom of boring at 16 ft, backfilled with auger cuttings
20ft											

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
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BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
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LGCI Engineer:	Alan Smith	Location:	Northern side of proposed building
Ground Surface El:	~ 215.5 ft (see remark 1)	Total Depth:	13 ft
Groundwater Depth:	Not encountered	Drill Rig Type:	Mobile B-48 track mounted rig
		Drilling Method:	3 ¼" Hollow stem augers
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Automatic	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0.5-2.5	S1	1	3	6	6	24	20		Topsoil	Hand dug 6" of topsoil
										Fill	S1 - Top 6": Topsoil Bottom 14": Poorly Graded SAND (SP), fine to medium, <5% fines, trace fine gravel, trace organics, brown, moist (fill)
5ft											
	5 - 7	S2	7	8	5	6	24	20			S2 - Top 9": Poorly Graded SAND with Silt (SP-SM), fine to medium, 10-15% fines, gray, moist (fill)
										Topsoil/ Subsoil	Middle 8": Poorly Graded SAND with Silt (SP-SM), fine, 10-15% fines with organics, dark brown, moist
	7 - 9	S3	5	6	8	11	24	24		7'	Bottom 3": Poorly Graded SAND with Silt (SP-SM), fine, trace medium, 10-15% fines, orange brown, moist
10ft	9 - 11	S4	4	6	7	8	24	14		Sand	S3: Poorly Graded SAND (SP), fine to medium, ~5% fines, brown, moist S4: Poorly Graded SAND (SP), fine to medium, <5% fines, light brown, moist
	11 - 13	S5	6	5	7	8	24	16			S5: Similar to S4
15ft											Bottom of boring at 13 ft, backfilled with auger cuttings
20ft											

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG

Project:	**Proposed Plymouth South High School, Plymouth, MA**		
Client:	**Ai3 Architects LLC**	LGCI Project No.:	1408
Drilling Subcontractor:	Northern Drill Service	Date Started:	04/25/2015
Drilling Foreman:	Tim Tucker	Date Completed:	04/25/2015
LGCI Engineer:	Alan Smith	Location:	Northern side of proposed building
Ground Surface El:	~ 215.5 ft (see remark 1)	Total Depth:	10 ft
Groundwater Depth:	Not encountered	Drill Rig Type:	Mobile B-48 track mounted rig
		Drilling Method:	3 ¼" Hollow stem augers
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Automatic	Rock Core Barrel Size:	N/A
Drop:	30 inches		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Remarks	Strata	Sample Description
	0.5-2.5	S1	1	2	7	8	24	19		Topsoil	Hand dug 6" of topsoil S1 - Top 3": Topsoil Bottom 16": Poorly Graded SAND (SP), fine to medium, ~5% fines, trace organics, brown, moist (fill)
5ft	4 - 6	S2	5	13	12	12	24	24		Fill	S2: Poorly Graded SAND with Silt (SP-SM), fine, trace medium, 10-15% fines, brown, moist (fill)
	6 - 8	S3	8	9	9	8	24	22		6' Topsoil/ Subsoil	S3 - Top 6": Poorly Graded SAND with Silt (SP-SM), fine, 10-15% fines, trace organics, gray, moist Middle 6": Poorly Graded SAND with Silt (SP-SM), fine, trace medium, 10-15% fines, orange brown, moist
	8 - 10	S4	5	7	9	14	24	15		7' Sand	Bottom 10": Poorly Graded SAND (SP), fine to medium, <5% fines, brown, moist ~~S4: Similar to bottom S3, except light brown~~
10ft											Bottom of boring at 10 ft, backfilled with auger cuttings
15ft											
20ft											

Remarks:
1 - Ground surface elevations estimated from plan titled " Overall Site Plan," dated July, 2014, by Ai3 Architects / Pare Corporation.

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APPENDIX D

MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION

APPROVAL LETTERS

FOR

CONSTRUCTION OF WATER TREATMENT FACILITY

AND

DISTRIBUTION SYSTEM MODIFICATIONS

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Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

Southeast Regional Office • 20 Riverside Drive, Lakeville MA 02347 • 508-946-2700

Charles D. Baker
Governor

Karyn E. Polito
Lieutenant Governor

Matthew A. Beaton
Secretary

Martin Suuberg
Commissioner

April 1, 2015

Mr. Frank Silva
Plymouth South High School
10 Oak Street
Plymouth, Massachusetts 02360

RE: PLYMOUTH--Public Water Supply
Plymouth South High School
PWS ID #4239046
BRP WS 23A, Approval to Construct Water Treatment Facility <40,000 gpd
Transmittal No. X264904

Dear Mr. Silva:

Please find attached the Massachusetts Department of Environmental Protection approval for the Water Treatment Facility to be located at the new Plymouth South High School, 490 Long Pond Road, Plymouth, Massachusetts.

Please note, the signature on this cover letter indicates formal issuance of the attached document. If you have any questions regarding this document, please contact Charles Shurtleff @ 508-946-2879.

Sincerely,

Richard J. Rondeau, Chief
Drinking Water Program
Bureau of Water Resources

R/CPS
Y:\DWP Archive\SERO\Plymouth-4239046-System Modifications-2015-04-01
Cshurtleff/ws23A/15.treatmentFacility<40,000.approval.X264904.4239046

ecc: Plymouth Board of Health

cc: Andrew J. Chagnon
Pare Corporation
10 Lincoln Road, Suite 103
Foxboro, MA 02035

RECEIVED
APR 6 2015
13102.04
Pare Corporation

File, BB, CPO

Plymouth South High School
490 Long Pond Road
Plymouth, Massachusetts
PWS ID #4239046
Approval to Construct Water Treatment Facility < 40,000 gpd
Transmittal #X264904

The Department of Environmental Protection (the Department or MassDEP) has reviewed a request from the Plymouth Public Schools for a permit to construct a water treatment facility to treat their existing wells, with the primary objective of corrosion control at the proposed New Plymouth South High School (New School). The New School is to be located at the site of the current ball fields of the Existing Plymouth South High School (Existing School). The application, received by the Department on February 26, 2015, was prepared and submitted on your behalf by Andrew J. Chagnon, P.E. of Pare Corporation, 10 Lincoln Road, Suite 103, Foxboro, Massachusetts.

The existing wells are currently successfully treated for corrosion control. The treatment plant is located in the Existing School. The New School will continue to utilize the water from the existing wells and, as such, will require corrosion control treatment at the site of the New School. The Existing School will remain in operation until the new School is ready for normal operations. This permit application is submitted for the corrosion control treatment to be located within the New School.

The design of the New School corrosion control treatment system will mimic the Existing School corrosion control treatment as it has proven effective in elevating the raw water pH from between a pH of 6.0-6.5 to a pH of 8.0. The design includes three 30-inch diameter, 72-inch high, up flow, calcium carbonate contact fiberglass pressure vessels. The 95% calcium carbonate sacrificial media will be supported, within the cylinder, by a gravel support layer. Designed as an "up flow" treatment system, backwashing of the media will not be required.

The design allows for a flow rate of 30 gallons per minute (GPM) for each of the three pressure tanks. A discharge flow rate will be restricted to 30 GPM from each tank with a maximum design flow rate of 90 GPM. The daily monitoring of the finish water pH will govern the need to replenish the calcium carbonate.

The Department, based upon its review of the information provided, is of the opinion that the water treatment design is consistent with current water works engineering principles. Pursuant to the Department's authority under 310 CMR 22.04(7) to require that each supplier of water operate and maintain its system in a manner that ensures the delivery of safe drinking water to consumers, this approval is made subject to the following conditions:

1. The approval of any and all work proposed within this permit application is site specific and shall not be interpreted or used as a blanket approval of the treatment installation.

2. All work shall be completed in accordance with the permit application proposal, this approval letter and the MassDEP regulations and guidelines.

3. Fourteen days prior to completion of the proposed work, notify the Department to schedule a final inspection.

4. Prior to final inspection, a Massachusetts registered professional engineer shall submit written certification that the new water treatment facility has been constructed in accordance

with this permit approval, submitted plans, and in compliance with the Department's Regulations, Guidance and Policies.

5. Daily recording of system pH will be required each day the facility is open and shall be reported to the Department on a monthly basis. The Department recommends that the location and time of pH monitoring be consistent.

6. An Operation and Maintenance (O&M) manual shall be prepared for the facility. The manual will include instructions for facility start up, shut down, and routine operation and shall include copies of inspection checklists and equipment operating data.

7. Submit Chemical Addition Forms monthly to the Department.

This approval pertains only to the water supply aspects of the proposal and, therefore, does not negate the responsibility of the owner or operator to comply with other applicable laws, and or regulations.

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Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

Southeast Regional Office • 20 Riverside Drive, Lakeville MA 02347 • 508-946-2700

Charles D. Baker
Governor

Karyn E. Polito
Lieutenant Governor

Matthew A. Beaton
Secretary

Martin Suuberg
Commissioner

April 1, 2015

Frank Silva
Plymouth South High School
10 Oak Street
Plymouth, Massachusetts 02576

RE: PLYMOUTH--Public Water Supply
Plymouth South High School
PWS ID #4239046
BRP WS-33, Distribution System Modifications,
< 3,300
Transmittal No. X264901

Dear Mr. Silva:

Please find attached the Massachusetts Department of Environmental Protection approval for the BRP WS-33 permit application, "Distribution System Modifications", for the proposed piping re-configuration to facilitate the connection of proposed New Plymouth South High School (the New School) to the existing Plymouth South High School (the Existing School) public water supply wells.

Please note, the signature on this cover letter indicates formal issuance of the attached document.
If you have any questions regarding this document, please contact Charles Shurtleff @ 508-946-2879.

Sincerely,

Richard J. Rondeau, Chief
Drinking Water Program
Bureau of Water Resources

R/CPS
Y:\DWP Archive\SERO\Plymouth-4239046-System Modifications-2015-04-01
Cshurtleff/ws33/15.ws33.approval.X264901.4239046

ecc: Plymouth Board of Health

cc: Andrew J. Chagnon
Pare Corporation
10 Lincoln Road, Suite 103
Foxboro, MA 02035

RECEIVED
APR 6 2015
13102.04
Pare Corporation
File, BB, CPO

Plymouth South High School
Plymouth, Massachusetts
PWS ID #4239046
BRP WS 33, Distribution System Modifications
Transmittal #X264901

On February 26, 2015, the Department of Environmental Protection ("MassDEP" or "the Department") received a BRP WS 33 permit application for distribution system modifications at the Plymouth South High School, 490 Long Pond Road, Plymouth, Massachusetts. The permit application was prepared and submitted on behalf of the School by Andrew J. Chagnon, P. E. of Pare Corporation, 10 Lincoln Road, Suite 103, Foxboro, Massachusetts.

The permit application which was submitted to the Department consists of a new piping configuration to allow the proposed new Plymouth South High School (New School) to connect to the existing public water supply wells that currently provide potable water to the existing Plymouth South High School (Existing School).

Drawings submitted with this permit application are titled as follows:

"Pare Corporation
10 Lincoln Road
Foxboro, Massachusetts
Plymouth South High School

Overall Utility Plan	drawing C4.0	February 20, 2015
Utility Plan 1	drawing C4.1	February 20, 2015
Utility Plan 2	drawing C4.2	February 20, 2015
Utility Plan 3	drawing C4.3	February 20, 2015
Utility Plan 4	drawing C4.4	February 20, 2015
First Floor Plan	drawing P1, 12	January 21, 2015
Overall First Floor Plan	drawing A1.10	January 22, 2015
Overall Second Floor Plan	drawing A1.20	January 22, 2015
Overall Third Floor Plan	drawing A1.30	January 22, 2015"

The permit application proposes the installation of 815 linear feet of 6-inch diameter ductile iron water main and appurtenances including, but not limited to, valves, hydrants, bends and sleeves as needed. Tap-and-sleeve valves will be installed approximately 380 feet from the existing wells between the wells and the Existing School. During construction of the New School, water will continue to be provided to the Existing School.

The Department, based upon its review of the information provided, is of the opinion that the waterline design is consistent with current water works engineering principles. Pursuant to the Department's authority under 310 CMR 22.04 (7) to require that each supplier of water operate and maintain its system in a manner that assures the delivery of safe Drinking water to consumers, this approval is made subject to the following conditions.

1. The approval of any and all work proposed within this permit application is site specific and shall not be interpreted or used as a blanket approval of the water main installation.

2. All work shall be completed in accordance with the American Water Works Association Standards, MassDEP regulation and guidelines and the Town of Plymouth associated standards.

3. Prior to occupation of the New School by teachers and/or students, the distribution shall be sampled for total coliform bacteria at locations determined by the Department and submitted as Special Samples (SS). These samples are to be taken after the new piping system is disinfected and all chemicals used for disinfecting the piping is flushed from the distribution system.

4. Prior to occupation of the New School by teachers and/or students, a Total Coliform Sampling Plan shall be submitted to, and approved by the Department and all required total coliform samples shall have been taken for the month the New School is to be occupied.

5. Fourteen days prior to completion of the proposed work, notify the Department to schedule a final inspection.

6. Prior to final inspection, a Massachusetts registered professional engineer shall submit written certification that the new water mains have been constructed in accordance with the permit approval, plans, and in compliance with the Department's Regulations, Guidance and Policies.