## Sustainable Building Design & Construction Narrative

Plymouth's new town hall facility has been designed to incorporate numerous sustainable building design and construction strategies. While qualifying for LEED certification was never part of the design mandate, the design team has made a significant effort to include as many "green" elements as possible without significantly effecting the overall project budget.

By starting with an existing historic building, this project utilizes existing building fabric and existing infrastructure to a large extent. As compared with a "greenfield" project on an undeveloped site, this project begins with a sustainable approach that not only utilizes an existing building, it also provides for walkability and connectivity to the existing town center. By locating the new Town Hall in the center of Plymouth, it is hoped that many people will walk or bike to the building. (Bike racks are being provided at two locations.) Occupants will also be able to walk to amenities such as restaurants, banks, stores, etc.

The new addition was designed to complement the existing 1820 Courthouse and re-use as much of the historic building as possible. Before later additions to the historic building were removed, a significant amount of historic fabric was salvaged for use within the new building. Salvaged elements include a substantial amount of granite, marble pavers, and brick. Historic stained glass and furnishings from the adjacent Registry of Deeds Building are also being incorporated into the new building as a means of increasing the amount of recycled elements within the project.

The new building maximizes occupant access to natural light and views to the exterior by utilizing an H-shaped plan that provides windows at nearly all interior spaces. All windows in the historic and new building will also be operable. Optimum building orientation was not pursued due to site constraints and the new building's relationship to the existing building.

Materials throughout the project were selected and specified to be durable, low-maintenance, and include at least 25% recycled content. Interior finishes, casework and doors are specified to be low-VOC, low-emitting, and contain no added urea formaldehyde. Specifications have been developed to include a construction waste management plan and indoor air quality management plan. The construction waste plan will require a minimum end-of-project rate for salvage and recycling of 50% by weight of total non-hazardous solid waste generated by the work. The construction indoor air quality management plan will require the building to be protected against moisture intrusion, will exclude moisture damaged materials from the work, will implement measures to limit contaminants into work areas, will make provisions to allow high VOC materials (if any) to off-gas prior to installation, will minimize the generation of dust, and will protect the HVAC system.

The design team includes a commissioning agent and an acoustical consultant, both of whom have conducted reviews of the project at the SD, DD and CD phases. The commissioning agent has developed the General Commissioning Specification and will be responsible for verification of the mechanical system operation during the construction phase. The acoustical consultant has reviewed the mechanical equipment, emergency generator and architectural elements to include upgrades and details to minimize noise transmission, both to the occupants of the building and to the exterior.

The most significant sustainability strategies focus on maximizing energy efficiency. After review and analysis of the MA Energy Code, it was determined that the new four-story addition will exceed the code. The existing 1820 Courthouse cannot be substantially altered, but since it is a historic building it is essentially exempt from the energy code. The design for the historic building does include new 12-inch thick blown-in cellulose attic floor insulation, new 8-inch thick batt insulation between the first floor and basement, new custom historic replica exterior wood doors, and a new mechanical system. The new mechanical equipment has been located in the new addition to avoid damage to the historic structure and minimize noise. New mahogany windows with bronze weatherstripping and laminated glass will replace the existing vinyl windows in the

historic Courthouse and will substantially improve the energy performance of the windows in the existing building.

The new four-story addition has an enhanced exterior thermal envelope and utilizes durable materials such as masonry veneer and zinc. The overall thermal envelope has been designed to exceed minimum code requirements by at least ten percent. The roof has been structured to accommodate future installation of photovoltaic panels. Mechanical, electrical and plumbing systems have been designed to be energy efficient and to exceed minimum energy code requirements. Where possible, mechanical equipment was located within the building envelope to avoid exposure to the coastal environment and thereby increase its longevity. Below are brief descriptions of some of the major components of the project.

Structure: The structural system consists of a structural steel frame set on cast-in-place concrete foundation walls with continuous spread footings. Slabs-on-grade are 4-inch thick reinforced concrete, and are set on a continuous 15-mil thick vapor barrier, over continuous 2-inch thick rigid insulation (R-10); which meets the energy code. Below grade foundation walls incorporate a continuous outer layer of 2-inch thick rigid insulation (R-10); which exceeds the energy code minimum of R-7.5. Also, concrete has been specified to include an integral crystalline waterproofing admixture to minimize water intrusion into the basement. The structural steel frame includes cross-bracing and moment frames to resist lateral loads. Elevated floor slab construction consists of light-weight concrete on 3-inch metal deck; for a total floor thickness of 6 1/4-inches.

Roofs: The new building incorporates predominantly steep-slope roofs, with small areas of low-slope roofing at the entrance canopies and at the new glass connector. Steep-slope roof coverings consist of heavy asphalt fiberglass shingles, over continuous self-adhered underlayment, on preformed ventilated nailable roof insulation; which includes a 1-inch air space and 5/8 inch thick fire-treated plywood sheathing. Low-slope roof coverings consist of fully adhered, 72 mil thick, tan colored, PVC membrane with heat welded seams, over a 1/4 inch thick cover/protection board, on a base layer of continuous rigid insulation. Minimum solar reflectance and aged thermal emittance criteria have been included as a requirement for the PVC roofing membrane; which exceeds the energy code. Roof drainage consists of external gutters and downspouts at steep-sloped roof area and roof drains with internal leaders at low-slope areas. Storm water is piped underground into an on-site infiltration system located in front of the Courthouse.

Insulation is continuous and will consist of multiple layers, with staggered joints. Tapered sloped areas include additional insulation layers sloped at a 1/4 inch per foot. All roof insulation will be installed over a continuous vapor barrier on the structural metal roof deck. Vapor barriers will be tied into wall air/water barriers. The roof insulation provides a minimum thermal resistance of R-30; but the energy code requires only R-25. Therefore, the new roof insulation will exceed code by approximately twenty percent. The incremental upgrades identified above have been included to maximize the energy efficiency of the building envelope, reduce loads on the mechanical system, and leverage available rebates from the utility company.

Walls: Exterior walls consist of 4-inch thick nominal masonry veneer, with a 2-inch airspace, in front of continuous 3-inch thick rigid polystyrene foam insulation, over a continuous fluid applied air/water barrier. Typical back-up wall construction consists of 1/2 inch exterior gypsum sheathing with a glass mat face, on 8-inch deep light gage metal studs at 16 inches on center. The energy code requires continuous insulation of R-7.5 and wall insulation of R-13. The designed exterior wall assembly

utilizes continuous insulation of R-15 with an overall assembly value of R-19.3. Dormer construction consists of flat-lock, 8-inch square zinc wall shingles, set over vented galvanized steel rain-screen framing, with 4-inch thick rigid mineral wool insulation, over typical metal stud back-up wall construction. The dormer wall assembly utilizes continuous insulation of R-17 with an overall assembly value of R-20.3.

Openings: New windows and louvers will be constructed of extruded aluminum, designed to meet both the energy code and the building code wind-borne-debris impact resistance requirements. Given these competing requirements, it was extremely difficult to exceed the energy code. For durability, all aluminum items have been specified to receive a Kynar 70% finish. All exterior joints will be sealed with silicone sealant and backer rod and receive low-expansion spray foam to close gaps between window frames and the surrounding construction, and to maintain the integrity of the wall air/water barrier.

Single-hung windows and awning windows have a specified total unit value of (U-0.42); but the energy code requires only (U-0.45). The basis of design products are "663G Single Hung Window" & "321G Projected Window" by EFCO. All aluminum windows will be operable and will receive insect screens. Single-hung windows shall receive Class 5 balances. Also, all exterior windows in the new addition and on the first floor of the 1820 Courthouse will be equipped with dual-roll shades that have one roll shade of light-filtering fabric with an openness factor of 14 percent; and another roll shade with 100 percent light-blocking fabric. These allow for greater end-user control of natural light to prevent glare and minimize dependence on artificial lighting.

The aluminum curtain wall has a specified total unit value of (U-0.38); which matches the energy code. The curtain wall basis of design product is the "5600 Series Curtain Wall" by EFCO. Aluminum/glass entrance doors have a specified total unit value of (U-0.77), which matches the energy code. The basis of design product is the "Series D500 Wide Stile Thermastile Entrance Doors" by EFCO. Flush aluminum doors are being utilized for non-fire rated exit doors. The doors have a specified total unit value of (U-0.61), which matches the energy code. The basis of design product is the "Series 100BE Flush Aluminum Door" by Cline Aluminum Doors, Inc.

Windows, curtain wall, and doors utilize high-performance insulated Low-E glazing consisting of a 1/4-inch thick fully tempered outer pane, 1/2-inch Argon filled air space, and an inner laminated impact light utilizing two 1/8-inch thick fully tempered panes laminated on each side of a 0.030-inch clear PVB interlayer. Exterior insulated glazing units have a specified value of (U-0.20). The basis of design glass is "SN68 with Argon and IS20" by Guardian Industries. The following performance characteristics have been specified: 65% visible light transmittance, 0.41 shading coefficient, 0.36 solar heat gain coefficient, and 11% outdoor visible light reflectance.

The ratio of window openings to solid wall was studied to maximize thermal envelope performance, while also providing for extensive day-lighting and views to the exterior. Windows, curtain wall, louvers and doors constitute approximately twenty-one percent of the total exterior building envelope at the new construction. The breakdown by elevation is as follows: North: 83% solid, 17% open; South: 75% solid, 25% open; East: 79% solid, 21% open; West: 78% solid, 22% open.

Shading: The design team analyzed the new glass connector for solar gain. A two-foot deep roof overhang and fritted glass bands were incorporated into the design to help shade the space and prevent undue over-heating and cooling.

Landscape: The plantings for the new town hall include a combination of native, naturalized and non-native plantings. Plantings have been specifically selected for their use as buffers, screening, shade to reduce heat island effect, and to create human scale to the exterior environments. Plants were also selected to be low-maintenance and will require minimal irrigation once they are established.

Mechanical/Electrical/Plumbing Systems:

HVAC: In order to reduce energy usage as much as possible, the new mechanical system has been designed to utilize high efficiency equipment, controlled and monitored by a building energy management system with DDC (direct digital control) automatic temperature controls. This system will also be interfaced with the Town's Master Management System. Energy metering of the HVAC systems and utilities (gas, electric and cold water) will also be included to monitor energy usage of these items. This will provide feedback for senior personnel to implement changes required to maintain targeted efficiencies. Most importantly, the entire HVAC system will be fully commissioned by the team's independent commissioning agent once the system is in place and operating. Commissioning is an important process and one that is required during LEED certification to ensure that the HVAC system is functioning with the energy efficiencies for which it was designed. ,

It is important to note that inclusion of a geo-thermal heating and cooling system was thoroughly explored during the Schematic Design Phase of the project, including order of magnitude pricing. The geo-thermal system was rejected by the Town due to concerns about operational costs and long term maintenance.

Below are detailed descriptions of the components of the system that is included in the project:

A. Central Heating Plant: Heating for the entire facility, including the historic 1820 Courthouse, will be achieved by utilizing a high efficiency gas-fired condensing boiler plant located in the new building. The design includes two, 1500 MBH boilers with end suction base mounted pumps, each having a capacity of 300 gpm. Efficiency will be significantly improved by using variable frequency drives (VFD's). The plant will supply hot water to all heating apparatus in the facility via a two-pipe, fiberglass insulated, schedule 40 black steel piping system. Insulation has been sized to minimize heat loss. The system will also receive a 35% propylene glycol solution and a make-up feed unit. The plant will supply a maximum hot water temperature of 160 deg F on a 0 degree day. Hot water supply temperature will be automatically adjusted downward, based on an outside temperature reset schedule, to improve overall operating efficiency.

B. Central Cooling Plant: Cooling for the entire facility will be achieved by utilizing a split, chilled water plant located in the new building. A high efficiency, air-cooled, Turbocor, liquid chiller with approximately 200 tons of cooling capacity will be located inside the mechanical room to increase longevity. An outdoor condenser, located in the adjacent areaway, will have matching cooling capacity and will be equipped with low noise condenser fan blades and ECM motors for head pressure control and modulation. A high-efficiency, turbo-core, oil-free compressor will distribute 45°F chilled water to all indoor air handling units. The system will also receive a 35% propylene glycol solution and a make-up feed unit. The plant will supply chilled water via fiberglass insulated, schedule 40 steel piping system. Insulation has been sized to minimize heat loss. This piping will be completely separate from the hot water heating piping. Primary and standby vertical split case base mounted chilled water pumps at 520 GPM each with a variable frequency drive (which will control down to maintain a minimum

flow to the chiller) will be provided for overall water system distribution. Pumps shall have lead/lag/alternating control capability to increase efficiency.

C. New Building General Office Spaces (All Floors): Fully conditioned air will be supplied via high-efficiency, indoor mounted, variable air volume, air handling units located in the new building mechanical room. These air handling units include supply and return fans with VFDs, energy recovery wheel, hot water heating section with modulating capacity control, chilled water cooling coil, sensible reheat wheel, Economizer control, and MERV 13 filtration. The following equipment is planned: (1) One indoor air handling units with a capacity of 16,500 CFM (80 Tons of Cooling, 280 MBH of Heating) & (1) One indoor air handling units with a capacity of 14,500 CFM (50 Tons of Cooling, 240 MBH of Heating). The system will utilize displacement ventilation. Supply air will be provided to individual spaces through a galvanized steel supply duct distribution system out to ceiling-mounted displacement ventilation diffusers. Within the distribution ductwork, a variable air volume terminal box will be provided to modulate flow to each space to provide temperature and CO2 control. Return air will be drawn back to the units by ceiling return air registers, and will be routed back to the indoor air handler unit through galvanized sheet metal return air ductwork. Supplemental hot water ceiling mounted radiant panel heating will be provided along all exterior walls. Each space will be provided with an individual room temperature, CO2 and humidity sensor that will control the amount of airflow delivered to the space through the VAV (variable air volume) terminal box.

D. Server Area: A stand-alone, heating and cooling system is planned for this area since it has been designated as a critical operations power system. The mechanical system consists of a high efficiency, variable refrigerant, ductless air conditioning-heat pump system. Ventilation air will be provided from the building displacement ventilation system. The following equipment is planned: (6) 1 ton variable refrigerant heat pump units. This system will be associated with two outdoor condenser units and interconnected with refrigerant piping.

E. 1820 Courthouse General Office Spaces (First Floor): Fully conditioned air will be supplied via high-efficiency, indoor mounted, variable air volume, air handling unit located in the new building mechanical room. The unit is similar to the New Building General Office Spaces. However, supply duct distribution system will be located within the basement of the original courthouse, and will connect to under floor mounted displacement diffusers. Return air ductwork and registers will be located in the first floor ceiling and in vertical chases to draw air back to the air handler. Supplemental hot water heating elements will be provided under all exterior windows within custom architectural enclosures. The following equipment is planned: (1) One indoor air handling unit with a capacity of 2,000 CFM (15 Tons of Cooling, 100 MBH of Heating).

F. 1820 Courthouse (Second Floor): Fully conditioned air will be supplied via high-efficiency, indoor mounted, variable air volume, air handling unit located in the new building mechanical room. The air handling unit includes supply and return fans with VFDs, energy recovery wheel, hot water heating section with modulating capacity control, chilled water cooling coil, Economizer control, and MERV 13 filtration. Supply and return duct distribution systems will be located within the attic. Supply to the courtroom will occur through two existing historic supply grilles. Return will be accomplished within the existing corridor wall utilizing the original chases on flanking sides of the judge's bench. The adjacent meeting space will be served by a ceiling mounted ductless cooling unit, with R410a refrigerant; ventilation air will be ducted directly to the unit. Each space will be provided with an individual room temperature, CO2 and humidity sensor

that will control the amount of airflow delivered to each space. The following equipment is planned: (1) One indoor air handling unit with a capacity of 4,000 CFM (20 Tons of Cooling, 200 MBH of Heating).

G. Utility Areas: The main electric rooms and IDF/Data rooms will be air conditioned by high efficiency, ductless, AC cooling units.

Electrical Lighting and Controls:

A. Interior Lighting System:
   1. General lighting fixtures consist of recessed mounted, indirect, LED luminaries with dimming drivers. The fixtures will be pre-wired to include dimming control, where natural daylight is available, and also for multi-level switching. The combination of all LED fixtures with the lighting control system makes this a particularly energy efficient system.
   2. Light power density will be 40 percent less than IECC 2012.
   3. Daylight dimming will be provided within 15 feet of glazing.
   4. Each area will be locally switched and designed for multi-level controls. Each office space and toilet room will have an occupancy sensor to automatically turn off lights when unoccupied. Daylight sensors will be installed in each room where natural light is available for dimming of light fixtures.
   5. The entire building will be controlled with an automatic lighting control system using the BMS control system for schedule programming of lights. Lighting in storage/utility rooms will be controlled via occupancy sensors.

B. Site Lighting System:
   1. Fixtures for area lighting will be low height, pole-mounted, cut-off, LED luminaries to ensure that no light spills over to neighboring properties and to preserve dark sky effects. Building perimeter lighting will be wall mounted, cut-off, LED fixtures located over exterior doors. The exterior lighting will be connected to the automatic lighting control system for both programmed hours of operation and photocell on/timed off operation.

Plumbing: The domestic water distribution system consists of fiberglass insulated, copper piping. Insulation has been sized to minimize heat loss. A central plant was ruled out after review of demand, distances between locations, heat loss, and need for a re-circulating pump system. Hot water to the custodial closets will be provided by gas fired, high efficiency, tankless water heaters to reduce energy consumption. Hot water to toilet rooms and kitchenettes will be provided by high-efficient, electric, point-of use water heaters. Low-flow plumbing fixtures that help reduce water consumption have been selected from the MA Board of Registration of Plumbing and Gas Fitters Accepted Products List. Toilets and urinals will be 1.6gpf, and Lavatories will be equipped with aerators to reduce consumption and ensure 0.5 gpm water usage. Most importantly, lavatories will have hands-free controls with automatic shut-off to eliminate the risk of faucets being left on.