

SECTION 000110

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SECTION 024100
SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and relevant sections of these Specifications, apply to the work specified in this Section.

1.2 SUMMARY

- A. This Section includes demolition and removal of the following:
1. Select portions of the building and the building structure as called for on the drawings.
 2. Retain and Protect the following items:
 - a. Retain and protect a minimum of six (6) representative samples of each type of historic exposed aggregate finishes, terrazzo flooring and granite faced frieze for sourcing of materials and for comparison to reference samples and mock-ups submitted for approval as required by Related Specifications. Three (3) of the six (6) samples shall be provided to the precast and cast stone fabricator; three (3) of the six (6) samples shall be provided to the Owner's Representative.
 - b. Site mold existing satyr's mask prior to removal from existing font. Retain and protect existing satyr's mask for comparison to reference samples and mock-ups submitted for approval as required by Related Specifications. Site mold and existing satyr's mask shall be provided to the precast and cast stone fabricator. Upon completion of fabrication, existing satyr's mask shall be returned to the Owner in same condition as that at time of removal from existing font.
- B. General Contractor shall provide weather protection, dust protection, shoring, staging, and bracing associated with their work. Each individual Sub-Contractor shall be responsible for removal of debris on a regular basis to prevent buildup of debris on the site.

1.3 RELATED WORK

- A. Work in this Section is related to and shall be coordinated and performed with Work specified in:
1. 033300 Architectural Concrete
 2. 034100 Structural Precast Concrete and Unit Cast Stone

1.4 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or recycled.
- B. Remove and Salvage: Detach items from existing construction and store for reinstallation.
- C. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or recycled.

1.5 MATERIALS OWNERSHIP

- A. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, demolished materials shall become the individual contractor's property and shall be removed from the Project site.
- B. Historic artifacts whether exposed or hidden behind existing construction are the property of the Owner.

1.6 SUBMITTALS

- A. Proposed Protection and Control Measures: Submit statement or drawing that indicates the measures proposed for use, proposed locations, and proposed time frame for their operation. Identify options if proposed measures are later determined to be inadequate. Include measures for the following:
 - 1. Environmental protection
 - 2. Dust control
 - 3. Noise control
- B. Schedule of Building Demolition Activities: Indicate detailed sequence of demolition and removal work, with starting and ending dates for each activity, interruption of utility services, and locations of temporary protection and means of egress.
- C. Pre-demolition Photographs or Videotape: Show existing conditions of present construction and site improvements that might be misconstrued as damage caused by building demolition operations. Submit before Work begins.
- D. Landfill Records: Indicate receipt and acceptance of construction demolition waste by a facility licensed to accept construction demolition waste.
- E. Remove all demolition materials, debris and rubbish from the site as soon as practicable. Do not permit any accumulation of debris on the site. Transport all demolition materials without spillage on the streets. Legally dispose of all debris including all material considered hazardous waste. Provide certificate of legal disposal.

1.7 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI A10.6 and NFPA 241.
- C. Pre-demolition Conference: Conduct conference at Project site.

1.8 PROTECTION AND SHORING

- A. Conduct the work in a manner giving prime consideration to but not necessarily limited by the following: Protection of the public and personnel; compliance with all state and federal regulations relative to the demolition and removal of material from the site: protection from the weather, control of noise, shocks, and vibration; control of dirt and dust; orderly access for storage of materials, protection of any other work to remain and coordination and cooperation with the Owner at all times.
- B. Use all means necessary to protect the existing work to remain before, during and after demolition and to protect the Work and materials of other trades.
- C. The General Contractor shall be exclusively responsible for the design and implementation of all shoring and bracing which is required in order to protect and retain building elements, walls and structural systems which are to remain. Schedule selective demolition work to avoid any unbraced or unstable structural conditions.
- D. Protect all elements that are to remain and all historic elements to be retained and/or re-set. Do not dismantle anything other than what is specifically indicated on the contract documents unless specifically requested to do so in writing by the Architect.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Survey existing conditions and correlate with requirements indicated to determine extent of building demolition required.
- B. Inventory and record the condition of items to be removed and salvaged.

3.2 PREPARATION

- A. Existing Utilities: Locate, identify, disconnect, and seal or cap off indicated utilities in the building.
 - 1. If required, arrange to shut off indicated utilities with the appropriate utility company.

2. If utility services are required to be removed, relocated, or abandoned, before proceeding with building demolition provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures. Temporary Shoring: Shoring, bracing, protective shoring, underpinning, and all other mechanical operations are the sole responsibility of the individual contractor. Temporary shoring, bracing, or other supports shall be individually designed by the individual contractor to safely support all dead, live, and wind loads as required, specified or necessitated by the construction procedures.

3.3 PROTECTION

- A. Existing Facilities: Protect adjacent walkways, building entries, and other building facilities during demolition operations.
- B. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during demolition and cleaned and reinstalled in their original locations after demolition operations are complete.
- C. Existing Utilities: Maintain utility services indicated to remain and protect them against damage during demolition operations.
 1. Do not interrupt existing utilities serving adjacent buildings.
- D. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction and as indicated.
 1. Protect existing site improvements, appurtenances, and landscaping to remain.
 2. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 3. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
 4. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.
- E. Dust control: Carefully control dust by implementing methods to reduce dust while cutting and removing materials. Employ wet methods of cutting. All cutting and grinding tools shall be fitted with vacuums.

3.4 DEMOLITION, GENERAL

- A. General: demolish existing items as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 1. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

- B. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and adjacent properties.
 - 1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
- C. Remove debris from elevated portions by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 - 1. Remove structural framing members and lower to ground by method suitable to minimize ground impact or dust generation.
- D. Concrete: Cut concrete full depth at junctures with construction indicated to remain, using power-driven saw, then remove concrete between saw cuts.

3.5 STRUCTURAL DISMANTLING

- A. Carefully study each item to be dismantled or demolished and determine the safest, least disturbing and potentially damaging method of disassembly.
- B. Where items are to be reassembled, number the items, photograph them and make a sketch of assembled items for re-use during re-assembly. Number each component with an appropriate non-permanent method of marking and note the points of contact or intersection and their orientation. Take photographs of all elements to be worked on before and after the work.
- C. Notify the Architect immediately if any damage has occurred to any of the dismantled items and propose appropriate methods of repair.

3.6 REPAIRS

- A. General: Promptly repair damage to adjacent construction caused by building demolition operations.
- B. Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.
- C. Restore exposed finishes of patched areas and extend restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing. Patch, repair, or re-hang existing walls, ceilings, and floors as necessary to provide an even-plane surface of uniform appearance.

3.7 DISPOSAL OF DEMOLISHED MATERIAL

- A. General: Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved facility and a properly licensed disposal facility as defined by Section 150A of Chapter 111 of M.G.L. 40. General Contractor shall identify the name and location of the licensed disposal facility.
1. Do not allow demolished materials to accumulate on-site.
 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Recycling. The following existing materials (to be removed) are to be recycled:
1. Existing aluminum storm windows
 2. Existing glazing
- C. Burning: Do not burn demolished materials.
- D. Disposal: Transport demolished materials off Owner's property and legally dispose of them.
- E. Legally dispose of all debris including all material considered hazardous waste. Provide certificate of legal disposal.
- F. Removal of items having lead-based coatings: remove, handle, and dispose of all existing items having lead-based coatings, and which are designated to be removed, in compliance with the following statutes and standards:
1. M.G.L. C111.55, 190-199A; 105 CMR 460.000 "Lead Poisoning Prevention and Control", 454 CMR 22.00 "Deleading Regulations", 29 CFR 1910.1025; Massachusetts Hazardous Materials Regulation at 310 CMR 30.00; 29 CFR Part 1926, "Safety and Health Regulations for Construction"; and 29 CFR Part 1926.62, "Lead in Construction". Also 29 CFR 1910.20, 134, 145, 1200, 29 CFR Subpart T, 40 CFR 61 Subpart A, 152, 40 CFR 241, 257, 261, 262; American National Standards Institute 29.2-79, 288.2-80; NIOSH Manual of Analytical Methods; Underwriters Laboratories 586-77 (R1982).
 2. Ensure that proper worker protection measures are implemented and maintained throughout the removal, handling, and disposal of existing materials having lead-based coatings applied thereto, in accordance with the requirements of OSHA 1926.62, entitled "Lead in Construction"

END OF SECTION

SECTION 024113

SITE PREPARATION & DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and relevant sections of these Specifications, apply to the work specified in this Section.

1.2 SUMMARY

- A. The work of this section includes all necessary site preparation, utility work, demolition and the removal of waste resulting from demolition, including, but not limited to the areas listed in this section.
- B. The following list of items is to be used as a guide and shall not be considered limiting the scope of the work.

1. Layout, Lines and Levels
2. Protection of Property
3. Removal and Stockpile of Site Elements to be reused
4. Removal of Trees and stumps
5. Removal of shrubs and other vegetation
6. Tree Protection
7. Canopy and Root Pruning of Existing Trees
8. Clearing and grubbing
9. Disconnecting, capping or sealing of utilities as required
10. Protection from injury or defacement of objects indicated by the Owner's Representative to be preserved.
11. Other features as indicated on the drawings.

1.3 RELATED SECTIONS

- A. Related Sections include, but are not limited, to the following:
 1. Section 024100 Selective Demolition
 2. Section 024119 Temporary Shoring, Bracing, and Protection
 3. Section 310000 Earthwork
 4. Section 312500 Erosion and Sedimentation Controls

1.4 REFERENCES

- A. NFPA 241 Safeguarding Building Construction and Demolition Operations.

1.5 SUBMITTALS

- A. Submit copies of requests for and certificates of severance of utility services to the Owner's Representative prior to start of site preparation work.
- B. Submit copies of demolition and disposal permits to the Owner's Representative prior to start of work of this Section.
- C. Photograph existing conditions of trees and plantings adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.
- D. Submit record drawings identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 LAYOUT, LINES AND LEVELS

- A. Before demolition is started, the site will be completely staked out for the work of this section for the Owner's Representative's approval of layout and for the Owner's Representative's approval of elements to be relocated. This laying out shall be performed by a licensed engineer or surveyor. Grade stakes shall be set where spot elevations are shown as required to grade properly, establish and maintain benchmarks. Where proposed site work elevations are to closely represent existing conditions, the Contractor shall shoot spot grades for reference and establish elevational bench marks for use in constructing the finished work.
- B. Before installation of site improvements is started, locations shall be staked out for the Owner's Representative's approval.
- C. The layout shall be subject to possible modifications whether by inaccuracies in existing grades, by elements designated to remain or by other site conditions. Except in the case of substantial increase in the quantity of materials authorized in writing by the Owner's Representative, these modifications shall not entitle the Contractor to additional compensation.
- D. When the Contractor submits his proposal, it will be interpreted to mean that he has examined the site, fully understands the existing and proposed conditions and has made due allowance for them in his proposal.

1.7 REQUIREMENTS OF REGULATORY AGENCIES

- A. All work shall conform to the drawings and specifications and shall comply with applicable codes and regulations.
- B. All work shall comply with all rules, regulations, laws and ordinances of the State of Massachusetts, the Town of Brookline, and of 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.
- C. The Contractor shall, at his own expense, secure and pay for all permits, inspections, fees and give all legal notices that may be required in connection with his work, including the notification of local utility companies regarding location of subsurface water, gas, electric and other utility lines.

1.8 PROTECTION OF PROPERTY

- A. The work of this Contract shall be executed in such a manner that no damage or injury will occur to the public, to all properties and structures off or on the site which may be in any way affected by the operations under the Contract. Any damage to on-site structures, streets, paving, gas, water, electric, or any other pipes, mains, conduits overhead or underground utility wire, fences, and any and all other property should be corrected at no cost to the Owner. Should any damage or injury be caused by the Contractor or anyone in his employ, or by work under this Contract, the Contractor shall, at his own expense, make good such damage and assume all responsibility for such damage and assume all responsibility for such injury without cost to the Owner.
- B. All areas of the site used for construction staging by the Contractor shall be fully restored (re-sodded, re-seeded, re-paved, etc.) to the satisfaction of the Owner prior to completion of the contract work.

1.9 PROTECTION OF SITE ELEMENTS

- A. No material shall be stockpiled, no equipment shall be parked or repaired and no oil, grease, gasoline, concrete or other debris dumped within 15 feet of plant materials or existing structures to remain.
- B. Active utilities existing on the site shall be carefully protected from damage. When an active utility line is exposed during construction, its location and elevation shall be plotted on the record drawings the Owner's Representative shall be notified in writing.
- C. Inactive or abandoned utilities encountered during construction operations shall be removed, plugged or capped as directed by the Owner's Representative and as indicated on the drawings. The location of such utilities shall be noted on the record drawings and reported in writing to the Owner's Representative.
- D. Any trees to remain that are damaged during construction shall be inspected by the Owner's Representative to determine whether the tree can be saved or must be removed. At the Owner's request, the Contractor shall pay for the services of a licensed Arborist to assess the condition of the tree and recommend removal or treatment. See sections 3.2 and 3.3 for further requirements.
- E. Where cuts expose or affect root systems of trees, the exposed roots shall be cut off cleanly and such areas shall be backfilled with topsoil as soon as practical and shall be watered and protected from further damage. Notify Owner's Representative before backfilling.

1.10 DEWATERING

- A. Keep excavation continuously free of water from all sources without extra cost to the Owner. Provide, maintain and operate pumps and related equipment, including standby equipment of sufficient capacity to keep excavations free of all water at all times and under any and all contingencies that may arise until the completion of the Contract.
- B. Dispose of water through temporary pipelines or ditches with discharge to suitable outfall points. Prevent erosion of surrounding areas. Protect roads and other improvements on the site. Build temporary culverts if required. At completion of dewatering, remove temporary facilities and restore subgrade, and damaged areas.
- C. Dewatering and obtaining a NPDES dewatering permit is the sole responsibility of the contractor.

PART 2 – PRODUCTS (Not Applicable)

PART 3 – EXECUTION

3.1 DEMOLITION

- A. Demolish and remove all site elements, structures, foundations, and paving as indicated on the drawings or as directed by the Owner's Representative.
- B. All precautions shall be taken to protect the public from flying or falling debris. Prevent dust and dirt from rising by thoroughly wetting masonry, concrete, and other debris.
- C. Plant material to remain as indicated on the drawings shall be protected at the drip line with 4' tall orange snow fencing. Fencing shall be staked with full height steel stakes installed at no wider than 6' intervals. Contractor shall repair and adjust fence as needed to maintain constant protection of the existing plant material during construction operations.
- D. Upon completion, all debris created shall be removed from site. Burning of materials on the job site will not be permitted. All staging, scaffolding, protective devices and other equipment not required by other trades shall be removed. All surfaces will be swept clean and site will be left free of any and all debris.
- E. Work under this Section is to be carried on under the direction of the Owner's Representative.

3.2 TREE PROTECTION

- A. Owner's Representative will be present during Clearing and Grubbing to locate and clearly flag trees and vegetation to remain or to be relocated.
- B. Protect trees to remain within the project site at drip line with 4' tall orange snow fencing as described above. Maintain fence for duration of the job. Remove when directed by Owner's Representative.
- C. Damage no plants to remain by burning, by pumping of water, by cutting of live roots or branches, or by any other means. No trees to be saved shall be used for crane stay, guys or other fastenings.
- D. Existing trees to be saved adjacent to the work which have, in the opinion of the Owner's Representative, become damaged, shall be assessed according to the measurement of \$400 per caliper inch measured in accordance with American Nurserymen's Association Guidelines, and deducted from the Contract amount. All expenses incurred shall be paid by the Contractor without additional cost to the Owner. These trees shall be removed, according to the Specification requirements for removals, the stumps grubbed out and removed, and the ground surface repaired. Costs for this removal shall be borne by the Contractor and are not to be included as part of the above schedule.

3.3 ROOT PRUNING

- A. All soil removal in the root zones of existing trees shall be done carefully by hand. As required for construction of new pavements, roots shall be pruned in accordance with the following:
 - 1. ANSI 133.1 Safety Requirements for Pruning, Trimming, Repairing and Removing Trees

2. National Arborist Association – Pruning Standards for Shade Trees, Revised 1988
- B. For trees measuring 12” in diameter or less, root cutting shall not occur closer than three (3) feet from the outer bark of the tree. For trees measuring greater than 12” in diameter, root cutting shall not occur closer than six (6) feet from the outer bark of the tree.
 - C. No more than 30% of the roots from one side of any tree shall be removed. If any root larger than two (2) inches in diameter is cut or removed from one side of the tree, the crown shall be reduced on the same side.
 - D. Roots shall be saw-cut cleanly with sharp tools. All exposed roots shall be backfilled with approved planting loam and watered.
 1. Cover exposed roots with burlap and water regularly.
 2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
 3. Coat cut faces of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
 4. Backfill with soil as soon as possible.

3.4 UTILITIES

- A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
 1. Arrange with utility companies to shut off indicated utilities.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 1. Notify the Owner not less than two days in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without the Owner’s written permission.

3.5 CLEARING AND GRUBBING

- A. Remove, trees and tree stumps, shrubs, grass, and other vegetation as indicated on contract documents.
- B. Do not remove trees, shrubs, and other vegetation indicated to remain.
- C. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.

- D. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18" below exposed subgrade.
- E. Use only hand methods for grubbing within tree protection zone.
- F. Chip removed tree branches and dispose of off-site.
- G. Fill depressions caused by clearing, grubbing and stump grinding operations with satisfactory soil material unless further excavation or earthwork is indicated.
- H. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

- A. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
- B. Remove subsoil and non-soil materials from topsoil, including trash, debris, weeds, roots, and other waste materials. All species on Massachusetts invasive species list shall be thoroughly uprooted and removed from the site.
- C. 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 or contamination by air-borne weed seed.
- D. Limit height of topsoil stockpiles to 72 inches.
- E. Do not stockpile topsoil within tree protection zones

3.7 DISPOSAL

- A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off the Owner's property.
 - 1. Burning on site is prohibited.
 - 2. 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.
- B. Contractor shall stockpile any items to be re-used on site and provide protection from theft, damage or vandalism.

END OF SECTION

SECTION 024119

TEMPORARY SHORING, BRACING AND PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and relevant sections of these Specifications, apply to the work specified in this Section

1.2 SUMMARY

- A. Detailing and installation of all required temporary shoring, bracing and support to enable the specified masonry dismantling, demolition, reconstruction and restoration to be completed in a safe and expedient manner.

1.3 REFERENCES

- A. Comply with the standard material specifications that apply to the materials used and manufacturer's instructions

1.4 SUBMITTALS

- A. Submit the following items to the Architect for review:
 - 1. Drawings showing shoring, bracing, and temporary supports
 - 2. A written sequence of all phases of restoration operations and related temporary support

1.5 QUALITY ASSURANCE

- A. Comply with all referenced standards for the products employed.
- B. Schedule all appropriate site visits and inspections.

PART 2 - PRODUCTS

2.1 MATERIALS AND PRODUCTS

- A. Products and materials that are appropriate to the application and permitted by the Massachusetts State Building Code

PART 3 - EXECUTION

3.1 TEMPORARY SHORING, BRACING AND PROTECTION

- A. The contractor shall be solely responsible for all means and methods of construction employed on this project including all temporary bracing, support and protection of the existing Structure. Contractor shall be prepared to retain the services of a Massachusetts registered professional structural engineer at his own expense if necessary in order to maintain safe and stable conditions on the project. Any sequences of work or methods indicated or implied in the contract documents are present only as assumptions on which the design of the permanent installations are based and are to be considered as a suggested option for review by the contractor.
- B. Field Survey and Analysis:
1. Field verify shoring locations and measure all existing geometry and note existing conditions. Locate points of attachment and support that will best suit progress of work.
 2. Perform a structural analysis of the areas to be affected by the work and determine loads on temporary shoring, bracing and support system.
- C. Design Shoring, Bracing and Protection:
1. Shoring and bracing shall be designed to maintain existing lines and surfaces without deflection during work. Design shall be in accordance with gravity dead, live and wind load resistance requirements of the Massachusetts State Building Code and referenced standards.
 2. Shoring and bracing shall be sufficient for existing and new material loads and anticipated construction loads.
 3. Shoring and bracing shall allow for distribution of loads to supporting structure and shall limit all movement to less than 1/16" at full loading. Stresses on supporting structure shall not exceed safe, commonly allowable stresses for the materials in consideration of their age and conditions. Bending members shall allow deflections of not more than the span lengths divided by 720 at full loading.
 4. Protection shall be detailed to protect the remaining structure, its contents, and the immediate environs against damage from falling projectiles, debris and/or soiling that is related to or a result of any of the operations that are part of this project. This shall include barricades, shields, tarpaulins, scrims and restraining devices, along with any other devices and structures as may be needed to provide safe protection. All structures shall be detailed and constructed to withstand all possible live, snow, wind and impact loads without failure.
- D. Construct shoring, bracing and protection in accordance with approved submittals and proper and standard construction practice. Work shall be installed so as not to permanently mar or stain the exposed masonry faces of the structure.
- E. Maintenance: Maintain shoring, bracing and support in a safe condition during all phases of work. Keep wood generally dry and at constant moisture content. Protect wood from swelling or shrinking with weather and humidity fluctuations.

- F. Removal: Remove all shoring and bracing after surrounding work is complete and precast concrete pieces have adequately cured for the structure to support itself. Remove all temporary inserts and clean all contact surfaces and plug all holes per applicable requirements of Section 034200 –Installation and Erection of Architectural Structural Precast Concrete.

END OF SECTION

SECTION 033300

ARCHITECTURAL CONCRETE

PART - 1 GENERAL

1.1 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and relevant sections of these Specifications, apply to the work specified in this Section.

1.2 SUMMARY

- A. Provide all labor, materials, and equipment necessary to complete cast-in-place concrete work with architectural concrete finishes described herein, as shown on the drawings, or reasonably inferable from either or both, including but not limited to the items noted below.
 - 1. Formwork, reinforcement, concrete materials, mixture design, placement, finishing, and curing.
 - 2. Provide architectural concrete finishes as specified in drawings for all exposed to view cast-in-place concrete work.
 - 3. Default finish for exposed work is a smooth-formed with smooth-rubbed finish
 - 4. Special Finishes include:
 - a. Exposed Aggregate Finish to match historic exposed aggregate finishes on existing structures, to be coordinated with and to match finishes specified within Cast Stone and Concrete Paving Specifications. Performance of finishing shall be executed so that results match design reference samples and mock-ups as well as retained samples of historic exposed aggregate finishes, as approved by Owner's Representative.

1.3 RELATED SECTIONS

- A. Related Sections include, but are not limited, to the following:
- B. Section 024100 "Selective Demolition" for the retention and protection of the following items:
 - 1. Retain and protect a minimum of six (6) representative samples of historic exposed aggregate finishes for sourcing of materials and for comparison to reference samples and mock-ups submitted for approval as required by these Specifications. Samples shall be selected by Owner's Representative in coordination with the contractor. Three (3) of the six (6) samples shall be provided to the precast and cast stone fabricator; three (3) of the six (6) samples shall be provided to the Owner's Representative.

C. Section 321313 Concrete Paving

D. Section 034100 Architectural Structural Precast Concrete and Unit Cast Stone

1.4 REFERENCES, STANDARDS, CODES, REGULATIONS

A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirement shall govern.

1. American Concrete Institute (ACI):

- a. 212 Guide for Use of Admixtures in Concrete
- b. 301 Specifications for Structural Concrete for Buildings.
- c. 302 Guide for Concrete Floor and Slab Construction
- d. 304 Guide for Measuring, Mixing, Transporting and Placing Concrete
- e. 305 Hot Weather Concreting
- f. 306 Cold Weather Concreting
- g. 308 Standard Practice for Curing Concrete
- h. 315 ACI Detailing Manual
- i. 316 Recommended Practice for Construction of Concrete Pavements and Concrete Bases.
- j. 318 Building Code Requirements for Reinforced Concrete

2. American Plywood Association (APA):

- a. Ref. 1 APA Design/Construction Guide, Residential and Commercial

3. American Society for Testing and Materials (ASTM):

- a. A 185 Welded Steel Wire Fabric for Concrete Reinforcement
- b. A 307 Carbon Steel Externally-Threaded Standard Fasteners
- c. A 563 Carbon and Alloy Steel Nuts
- d. A 615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- e. C 33 Concrete Aggregates
- f. C 42 Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
- g. C 94 Ready-Mixed Concrete
- h. C 143 Slump of Portland Cement Concrete
- i. C 150 Portland Cement
- j. C 171 Sheet Materials for Curing Concrete
- k. C 231 Air Content of Freshly Mixed Concrete by the Pressure Method
- l. C260 Air Entraining Admixtures for Concrete
- m. C 309 Liquid Membrane-Forming Compounds for Curing Concrete
- n. C 494 Chemical Admixtures for Concrete
- o. C 618 Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
- p. D 1557 Moisture - Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb. (4.5-kg) Rammer and 18-in. (457

- q. D 1752 mm) Drop
Preformed Sponge Rubber and Cork Expansion Joint
Fillers for Concrete Paving and Structural Construction.
 - r. F 436 Hardened Steel Washers
- 4. American Concrete Institute (ACI):
 - 5. SP-66 - American Concrete Institute - Detailing Manual
Concrete Reinforcing Steel Institute (CRSI):
 - a. Manual of Practice
 - b. Placing Reinforcing Bars

1.5 DEFINITIONS

- A. Cast-in-Place Architectural Concrete: Formed concrete that is exposed to view on surfaces of completed structure, site walls or building and that requires special concrete materials, formwork, placement, or finishes to obtain specified architectural appearance.
- B. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume: subject to compliance with requirements.

1.6 SUBMITTALS

- A. Submit the following
 - 1. Design Mixtures: Proportion mix in accordance with ACI 211 and ACI 318. Submit process and substantiating data for proportioning to the Engineer at least fourteen (14) days prior to placement. The submittal shall include the following:
 - a. Mix proportions.
 - b. Source of cement, type, and brand.
 - c. Source and gradation of coarse and fine aggregates in accordance with ASTM C33 and ASTM C40.
 - d. Copies and analysis of the 7-day and 28-day test results from which the specified mix was proportioned.
 - e. Copies of other test results to Engineer as required to determine compliance.
 - f. Tests for approval of concrete mixtures shall be paid for by Contractor.
 - 2. Steel Reinforcement Shop Drawings: Submit shop drawings which include the following:
 - a. Indicate yield strength and type (new billet, axle, etc.) of reinforcing.
 - b. Indicate reinforcing bar sizes, spacings, locations, lengths, quantities, splices and locations, lengths, bending and cutting schedules, concrete cover and supporting and spacing devices in accordance with ACI 315 and ACI 318.

- c. Locate reinforcing splices not indicated on Drawings at points of minimum stress. Indicate location of splices on shop drawings.
 - d. Do not scale design drawings.
3. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 - a. Location of construction joints is subject to approval of the Engineer.
4. Curing and Protection: Submit detailed methods for curing and protecting concrete in hot, cold, and normal conditions in accordance with ACI 305R, ACI 306R, and ACI 318.
5. Manufactures' Technical Data: Submit catalog cuts, technical data and manufacture's recommendations on quantity, use, and applications for each of the following:
 - a. Adhesives.
 - b. Admixtures.
 - c. Bonding agents.
 - d. Curing compounds.
 - e. Form release agents.
 - f. Mechanical connectors
 - g. Non-shrink grout.
 - h. Vapor barriers.
 - i. Waterstops.
6. Welders' Qualifications: Submit copies of American Welding Society (AWS) qualifications for all welders performing work in the shop and field in accordance with the AWS. Welders shall be re-qualified if there has been any break in their service since the date on their current qualification.
7. Inspection and Testing Reports: Submit copies of inspection and testing reports directly to the Engineer within three (3) days of performance.

1.7 QUALITY CONTROL AND MOCK-UP PANEL

- A. Preconstruction Conference: Attend a preconstruction conference prior to the start of architectural concrete construction as directed by the Owner's Representative. Discussion will include the following:
 1. The Contractor's program to obtain the specified quantity of architectural concrete
 2. The procedures and methods for construction or preconstruction mock-ups specified herein.
- B. Preconstruction Mock-up Panel or Area
 1. General

- a. Schedule mock-up casting for acceptance 30 days prior to casting of architectural concrete surfaces represented by mock-ups.
- b. Locate mock-up panels in non-public areas accepted by the Owner's Representative. Brace panels as required for safety.
- c. Construct mock-ups to demonstrate the ability to cast architectural concrete to achieve shapes, color, and textured finishes required.
- d. Provide full scale portion of concrete element. Dimensions to be as determined by the Owner's Representative.
- e. An eased edge and a chamfered edge shall be included in the mock up. The Owner's Representative will choose which edge to use on the final concrete work.
- f. Continue to cast up to 3 mock-ups until acceptable mock-up is produced. Accepted mock-up shall be the standard for color, texture, and workmanship for the finished work.
- g. Mock-up sequence of forming, placing, form removal, curing and finishing, cutting control joints and edge tooling shall be reviewed and accepted by the Owner's Representative and must be the same as is used on the final work.
- h. Protect accepted mock-ups from damage until completion and acceptance of the work represented by the mock-up.
- i. The approved mock-up shall serve as a standard of appearance for the final work.
- j. Remove mock-ups from site at completion of project as directed by the Owner's Representative.
- k. Perform Work in accordance with ACI 301
- l. Detailing and construction of formwork, shoring and bracing shall be sufficient to maintain required alignments and surfaces. All work shall conform to ACI 318 and ACI 301, the Massachusetts State Building Code, and accepted construction practice.
- m. The contractor shall take samples of concrete and pay for them to be compression tested by a qualified, independent testing laboratory per Subsection 3.7 of this Section.

2. Source of Materials

- a. Utilize the same source, stock or brand of concrete materials for each class or mix of architectural concrete. Do not interchange materials or mixes until an additional mock-up shows that uniformity in finish, texture, and color, as compared to original mock-up will be maintained. If necessary, obtain and stockpile materials in sufficient quantity to ensure continuity and uniformity.

1.8 SCHEDULING

- A. Notify Engineer and testing agency at least 48 hours in advance of placing concrete.
- B. Notify Engineer at completion of formwork and placement of reinforcing.
- C. Formwork placement and reinforcing placement shall be completed at least 24 hours in advance of placing concrete.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs only project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI- certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94 requirements for production facilities and equipment.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4 "Structural Welding Code-Reinforcing Steel."
- D. Concrete Testing Service: Engage an independent testing agency qualified according to ASTM C 1077 and ASTM E329 to perform material evaluation tests and to design concrete mixtures.
- E. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- F. Dimensions, locations, and details of equipment pads, anchors, supports, and similar features indicated on Drawings are approximate. Manufacturer's approved shop drawings of equipment to be supported, anchored, or contained thereby shall be consulted for exact location, size, and details.

1.10 EVALUATION AND ACCEPTANCE

- A. Strength level of concrete will be considered satisfactory if averages of all sets of three consecutive strength test results equal or exceed specified strength and no individual test result (average of two cylinders) is below specified strength by more than 500 psi.
- B. Completed concrete work will be accepted when requirements of ACI 301 Chapter 18 have been complied with.
- C. Where the average strength of laboratory control cylinders, as shown by tests for any portion of structure, falls below minimum ultimate compressive strength hereinbefore specified, Owner's Representative shall have the right to require Contractor to provide improved curing conditions of temperature and moisture to secure required strength. Also, if average strength of laboratory control cylinders should fall so low as to cause portions of structure to which respective unsatisfactory test reports apply to be in question by Owner's Representative, Contractor shall, at his expense, follow core procedure set forth in current edition of ASTM C 42. If results of the core tests indicate, in opinion of Owner's Representative, that strength of structure is inadequate, such replacement, load testing, or strengthening as may be ordered by Owner's Representative shall be provided by Contractor without cost to Owner.
- D. Owner's Representative shall have the right to reject concrete represented by low strength tests. Rejected concrete shall be promptly removed and replaced

with concrete conforming to specification. Decision of Owner's Representative as to whether substandard concrete is to be accepted or rejected shall be final.

PART - 2 PRODUCTS

2.1 FORMWORK MATERIALS

- A. Concrete Surfaces Exposed-to-View: Shall be formed using pre-fabricated forms constructed of HDO (high density overlay) plyform, or smooth fiberglass. Furnish in largest practicable size to minimize the number of joints.
 - 1. Plywood: Sound, undamaged sheets with straight edges. Minimum thickness of 3/4", B-B plyform or HDO plyform.
 - 2. Fiberglass: Matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to structural tolerances and appearance of finished concrete surface.
 - 3. Metal Frame and Plywood Face Combination: Minimum thickness of 5/8" facing, matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to structural tolerances and appearance of finished concrete surface.
- B. Concrete Surfaces Not-Exposed-to-View: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Cylindrical Forms: Sonotube Fibre Forms, wax-impregnated strippable forms manufactured by Sonoco Products Company, General Products Division or approved equal, or ABS or PVC plastic reusable forms.
- D. Form Ties: Removable metal of fixed length, cone type, 1-1/2" break back dimension, free of defects that will leave holes 1" in diameter in concrete surface by 1-1/2" deep with waterproofing washer.
- E. Form Release Agent: Colorless material which will not stain concrete, absorb moisture or impair natural bonding or color characteristics of coating intended for use on concrete. Form release agent to be non-toxic after thirty (30) days.
- F. Fillets for Chamfered Corners: Wood strips or rigid plastic type, nailed six inches on center; size as indicated on the Drawings; maximum possible lengths.
- G. Nails, Spikes, Lag Bolts, Through Bolts, and Anchorages: Sized as required for strength and character to maintain formwork in place while placing concrete.

2.2 STEEL REINFORCEMENT AND ACCESSORIES

- A. Reinforcing Bars: ASTM A615, Grade 60, deformed bars.
- B. Low-Allow-Steel Reinforcing Bars: ASTM A706, deformed bars.
- C. Epoxy Coated Reinforcing Bars: ASTM A615, Grade 60, deformed bars, epoxy coated, with less than 2% damaged coating in each 12" bar length.

- D. Welded Wire Fabric: ASTM A185, plain, fabricated from as-drawn steel wire into flat sheets.
- E. Galvanized Welded Wire Fabric: ASTM A185, plain, fabricated galvanized-steel wire into flat sheets.
- F. Mechanical Connectors: All mechanical connectors for reinforcing shall be threaded type developing 125% of the yield capacity of the spliced bars.
- G. Tie Wire: Minimum 16-gauge annealed type.
- H. Chairs, Bolsters, Bar Supports, and Spacers: Sized and shaped for strength and support of reinforcement during concrete placement conditions.
- I. Accessories in Contact with Formwork: Plastic or plastic-coated with upturned legs.
- J. Joint Dowel Bars: ASTM A615, Grade 60, plain-steel bars, cut true to length with ends square and free of burs.
- K. Fabricate steel reinforcing according to CRSI's "Manual of Standard Practice." Tie reinforcing bars in bundles and tag with non-rusting tags showing shop drawing mark numbers.
- L. Fabrication of reinforcement shall be performed in the shop. Field fabrication of reinforcement may be permitted for mildly reinforced continuous strip footing, spread footings, frost walls, and masonry walls upon prior approval of the Engineer.
- M. All discontinuous bars to be detailed with 90° end hook or spliced to a bar with a 90° end hook with a Class B splice.
- N. All reinforcing splices to be Class B unless specified otherwise.
- O. Do not heat bars for the purpose of bending.

2.3 CONCRETE MATERIALS

- A. Cement: Use American Portland Cement of standard manufacture, free from foreign matter and damp set. Cement shall be free from water soluble salts or alkalis which will cause efflorescence on exposed surfaces. Unless otherwise permitted by the Engineer, conform to ASTM C150, Type II for normal cement and Type III for high-early strength cement. Do not change brands or types of cement without the prior approval of the Engineer. The use of air-entrained cement is prohibited.
- B. Aggregates:
 - 1. General: All aggregates are subject to the Engineer's review. Do not change the source of aggregates without the prior approval of the Engineer. Do not use frozen aggregate.

2. Fine Aggregate: Use natural sand conforming to ASTM C33 (3/8" maximum); free of injurious amount of shale, alkali, organic matter, loam, or other deleterious substances. Do not use manufactured sand without the prior approval of the Engineer.
 3. Coarse Aggregate: Use clean crushed stone or gravel conforming to ASTM C33, coarse aggregate gradation No. 67 (3/4" maximum).
- C. Water: Water for mixing concrete shall be clean, fresh, and free of oils, acids, alkali, organic materials, or other deleterious substances. It shall be potable, meeting the requirements of ASTM C94.

2.4 CONCRETE MIX

- A. General: Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 211 and ACI 318. The cost of developing mixture designs shall be paid for by the contractor.
1. Use qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Design Mixtures: Proportion mixtures to produce concrete to meet the following criteria:
1. For finish concrete that will be visible:
 - a. Minimum 28-day compressive strength shall be 4,500 psi.
 - b. Concrete slump shall be between 2" and 4", determined in accordance with ASTM C 143.
 - c. Maximum Water-Cement Ratio (w/c) shall be 0.45
 - d. Air content to be 4.5%-7.5%
 2. For concrete slabs, footings that will not be visible
 - a. Minimum 28-day compressive strength shall be 4,000 psi.
 - b. Concrete slump shall be between 2" and 4", determined in accordance with ASTM C 143.
 - c. Maximum Water-Cement Ratio (w/c) shall be 0.45-.50
 - d. Air content to be 4.5%-7.5%
- C. Concrete: air-entrained type, conforming to ASTM C 94. One copy of Certificate of Delivery required by ASTM C 94 shall be delivered to Owner's Representative immediately upon arrival of each load of concrete at site.
- D. Concrete shall contain a water reducing agent to minimize water-cement ratio of mix, at specified slump.
- E. No calcium chloride or admixtures containing calcium chloride shall be added to Concrete. No admixtures other than those specified shall be used in concrete without specific written permission of Owner's Representative

- F. No additional water, except for amount indicated by design mix shall be added to concrete without prior permission of Owner's Representative.
- G. No concrete shall be placed by pumping methods without prior written approval of Owner's Representative. Should Contractor be allowed to place concrete by pumping methods, pumping procedures, mix design of concrete, and other precautions shall be in accordance with ACI 304 and subject to review by Owner's Representative.

2.5 ADMIXTURES

- A. Air Entrainment: ASTM C260.
 - 1. Use air entrainment admixture in concrete exposed to exterior environment and in accordance with manufacturer's written instructions.
- B. Water Reducing Agent: ASTM C494, Type A.
- C. High-Range Water Reducing Agent (HRWR)
 - 1. Use in concrete with water-cement ratios equal to or less than 0.45, but do not exceed 8 inches slump.
 - 2. Use in concrete where anticipated slump losses in transit prevent proper pumping, placing and finishing. Use HRWR instead of adding water at the site. Do not exceed 8 inches slump.
- D. Accelerating Admixture: ASTM C494, Type C.
- E. Water-reducing Set Retarders: ASTM C494, type D. Set retarder shall be used whenever a monolithic pour exceeds 35 cubic yards in order to have sufficient delivery, placement, vibration, and compaction.
- F. Superplasticizers: Where permitted by Owner's Representative and where indicated in approved concrete design mix, a high-range water-reducing (HRWR) admixture (superplasticizers) complying with ASTM C 494, Type F or Type G, and containing more than 0.05% chloride ions, may be used subject to the following requirements:
 - 1. When a high range water-reducing admixture is used, the air-entraining admixture shall be a neutralized vinsol resin solution.
 - 2. Concrete shall arrive at the jobsite having a slump conforming to the requirements specified in Paragraph 2.4. HRWR shall be added after the concrete has been thoroughly mixed and the desired initial slump has been achieved.
 - 3. Water to cement ratio shall not exceed 5.0 gal/cwt (0.42 weight basis).
 - 4. Pretesting of the concrete shall be performed under guidance of admixture manufacturer's representative to determine dosage, addition times, and compatibility with other admixtures and mixture constituents.
 - 5. HRWR shall be added at job site and shall be dispensed to truck mixer using automatic dispensing equipment which accurately measured dosage.
 - 6. Slump after addition of HRWR to concrete shall be no greater than is necessary for proper placement and compaction and shall in no case

- exceed 7 in.
7. Air tests shall be run on admixed concrete as placed, and air content shall be within specified limits.
 8. HRWR admixture: "Melment", manufactured by American Admixtures Corp., Chicago, IL; "WRDA-19", manufactured by W. R. Grace & Co.; "Daracem 100", manufactured by W.R. Grace & Co.; "Eucon 37", manufactured by The Euclid Chemical Co.; "Sikament", manufactured by Sika Chemical Co., or approved equal.
 9. Dosage as determined by mix design.
- G. Color Admixture: Shall conform to ASTM C979, ACI 303.1, ASTM C494 and ASSHTO M194. Color Admixture for integrally colored concrete shall be synthetic mineral-oxide pigment or colored water-reducing admixture; color stable, nonfading, and resistant to lime and other alkalis.
1. Color: As selected by the Owner's Representative from manufacturer's full range. Color Admixture shall be selected in order to match historic exposed aggregate finishes on existing structures, to be coordinated with and to match finishes specified within Cast Stone Specifications. Performance of finishing shall be executed so that results match design reference samples and mock-ups as well as retained samples of historic exposed aggregate finishes, as approved by Owner's Representative
- H. No other admixtures are permitted without the prior approval of the Engineer.
- I. Admixtures shall be compatible with one another and with aggregates, cement, finishing materials, and other materials which may be affected thereby. Use of chemical admixtures by one company is recommended.
 - J. Adjust the quantities of admixtures to account for the common effects of different admixtures. For example, reduce the air entraining admixture if set retarder used has air entraining properties.
 - K. The use of calcium chloride or any admixture which contains calcium chloride or other chloride based ingredients shall not be permitted.

2.6 CURING MATERIALS

- A. Water: Water for curing concrete shall be clean, fresh, and free of oils, acids, alkali, organic materials, or other deleterious substances. It shall be potable, meeting the requirements of ASTM C94.
- B. Liquid Membrane Curing Compound: ASTM C309, Type I, A. with a VOC content of 350 g/L or less. Product used shall be shown to be compatible with the later application of coatings.
- C. Absorptive Cover: AASHTO M182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 o.z./s.q. yd. when dry.
- D. Moisture-retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

2.7 RELATED MATERIALS

- A. Bonding Agent: ASTM C1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- B. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application/in-service temperature and of grade to suit requirements, and as follows.
 - 1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- C. Non-shrink Grout: ASTM C1107, CRD C621, pre-mixed grout, non-metallic. Grout strength shall be 3,000 psi at 7-day and 5,000 psi at 28-day and shall be amended with mineral oxide-based pigments as well as aggregates in order to match architectural structural cast stone units where exposed.
- D. Vapor Barrier: ASTM E1745, Class A except with a maximum perm rating of 0.01, and minimum thickness of 15 mils. Include manufacture's recommended adhesive and/or pressure-sensitive tape.
- E. Waterstops: Waterstops shall be either Wirestop by the Paul Murphy Plastics Company or Volclay Waterstop RX, as shown on the Drawings.
- F. Sleeves shall be galvanized steel pipe, Schedule 40.

PART - 3 EXECUTION

3.1 SUITABILITY OF SUBGRADE

- A. Aggregate subbase to receive concrete slab-on-grade shall be inspected to ensure material is suitable to receive concrete, including compaction. Subgrade unacceptable shall be brought to the attention of Owner's Representative.

3.2 PREPARATION OF SUBGRADE

- A. Subgrade shall be compacted as required to bring top 6 inches of subgrade material immediately below the concrete to a density of not less than 95% at optimum moisture content as determined by ASTM D 1557. Subgrade compaction shall extend for a distance of at least one foot beyond edge of concrete.
 - 1. Existing subgrade material which will not readily compact shall be removed and replaced with satisfactory materials. Additional materials needed to bring subgrade to line and grade and to replace unsuitable material removed shall conform to Earthwork Section.

3.3 CONCRETE MIXING

- A. Ready Mix Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94, and furnish batch ticket information.

1. When air temperature is between 85 and 90° F, reduce mixing and delivery time from 90 minutes to 75 minutes; when air temperature is above 90° F, reduce mixing and delivery time to 60 minutes.
- B. The amount of any water added at the site shall be documented and indicated on the concrete test reports and recorded on the batch ticket together with the water content of the aggregates.

3.4 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until the structure can support such loads.
- B. Construct formwork so concrete members and structure are of size, shape, and alignment, elevation, and position indicated, within the tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
 1. Class A, 1/8", for smooth-formed finished surfaces.
 2. Class B, 1/4", for rough-formed finished surfaces.
- D. Minimize form joints. Symmetrically align joints and make water tight to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 1. Install keyways, reglets, recesses, and the like, for easy removal.
 2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Form openings, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in work. Determine sizes and locations from trades providing such items.
- I. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

- J. Seal form joints and penetrations at form ties with form joint tape or form joint sealant to prevent mortar leaks.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.5 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Accurately position, support, and secure reinforcing against displacement by firmly wiring at intersections and splices with tie wire, or by use of acceptable clipping devices. Place reinforcing using standard bar supports. Supporting reinforcement with wooden blocks, concrete bricks or blocks, clay bricks or any non-standard supports will not be permitted.
- D. All reinforcing is to be secured in position prior to placing concrete. Drilling or pushing rebar into position in concrete is not permitted.
- E. Weld reinforcing bars according to AWS D1.4, where indicated.
- F. Bending of reinforcing partially embedded in hardened concrete is not permitted, unless noted otherwise.
- G. Misplacement, misalignment or improper length of dowels shall be sufficient cause to require removal and reconstruction of the affected work.
- H. Provide Minimum Clear Cover as follows:
 - 1. Concrete placed against earth: 3 in.
 - 2. Formed concrete exposed to earth, water or weather: 2 in.
 - 3. Interior faces of walls: 1 in.
 - 4. Columns or piers (main reinforcement): 2 in.
- I. Tie wire shall have the same protective cover as the reinforcing it is tied to.
- J. Install welded wire reinforcement in longest practical lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
- K. Do not cut or puncture vapor barrier. Repair damage and reseal vapor barrier before placing concrete.

- L. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D3963. Use epoxy coated wire ties to fasten epoxy-coated steel reinforcement.

3.6 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 1. Install anchor rods, foundation bolts, and other embedded items, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
 - 2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
 - 3. Install dovetail anchor slots in concrete structures as indicated.
 - 4. Conduits embedded in concrete shall comply with Chapter 6, Section 6.3 of ACI 318. Review proposed conduit installations with the Engineer prior to performing the work.
 - a. Conduits are not permitted within concrete slabs on metal deck.

3.7 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Compressible filler at expansion joints shall be polypropylene foam joint filler product that is flexible, waterproof, lightweight, odor-free and compatible with hot-pour and cold-applied sealants
- C. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by the Owner's Representative.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 - 2. Form keyed joints as indicated. Embed keys at least 1 1/2" into concrete.
- D. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one fourth of concrete thickness as follows:
 - 1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8" wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

- E. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations.
- F. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.8 WATERSTOPS

- A. Install in construction joints and at other locations indicated, according to manufacturer's written instructions. Install in longest lengths practicable.

3.9 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Consistency and Quality of Concrete: Mix, transport and place concrete so as to maintain proper consistency, to avoid segregation, and to ensure placement in final position before initial set takes place. Re-tempering of concrete is prohibited. Control the rate of placement so that the concrete remains plastic and flows readily into spaces between the reinforcing bars, and can be worked into corners and around inserts without forming voids.
- C. Conveying:
 - 1. General: Handle concrete from the mixer to the place of final deposit as rapidly as practicable and in a manner which will assure that the specified quality of the concrete is obtained.
 - 2. Equipment: Provide conveying equipment of proper size and design to ensure a continuous flow of concrete to the delivery end. Conveying equipment will be subject to the Engineer's review. Do not use aluminum.
- D. Depositing:
 - 1. General: Do not deposit concrete which has partially hardened or has been contaminated by foreign matter.
 - 2. Segregation: To avoid segregation, deposit concrete as near as possible to its final position. Do not subject concrete to any procedure which will cause segregation. Do not drop concrete more than three feet; use elephant trunks where required to limit drop.
 - 3. Placing: All concrete shall be placed in accordance with ACI 304. Deposit concrete continuously in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause seams or planes of weakness. Between construction joints place concrete in a continuous operation so that concrete is plastic at all times and flows readily into spaces between reinforcement. Under no circumstances shall concrete be placed over standing water, mud, ice,

snow, or frozen material. The horizontal distribution of concrete by spading or vibration is prohibited.

4. Consolidation: Immediately after placing, thoroughly consolidate all concrete by internal vibrators, supplemented by hand spading and rodding in accordance with ACI 309. Provide mechanical vibrations with a minimum frequency of 8,000 vibrations per minute when submerged in concrete. Use of external form vibrators or tapping forms is not permitted. Apply vibrators at uniformly spaced points not further apart than the visible effectiveness of the machine. Vibrate concrete sufficiently to produce satisfactory consolidation without causing objectionable segregation. It is prohibited to use vibrators to transport concrete in the forms.
5. Placing concrete over footings or foundations: Do not pour walls, piers, or columns over previously constructed footings or foundations until footings or foundations have cured three (3) days or until concrete test cylinders have achieved 50% of design strength.

- E. Allow a minimum of 24 hours between adjacent pours when casting foundation slabs or walls.

3.10 WEATHER CONDITIONS

- A. Cold-Weather Placement: When air temperature is below 40° F concreting shall comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 1. Temperature shall be measured at intervals not less than twice in a 24 hour period, twelve hours apart.
 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-Weather Placement: When air temperature exceeds 90° F concreting shall comply with ACI 305R.

3.11 CONCRETE CURING

- A. Vertical Surfaces: Liquid curing compounds sprayed or brushed uniformly in single coat on all surfaces immediately following form removal and the final finishing operation in accordance with manufacturer's instructions. Apply a second coat at right angles to the first as soon after the first coat is applied as suggested by the manufacturer. Protect exposed reinforcing steel or any surface against which additional concrete or other cementitious finishing materials are to be bonded from concrete curing compounds.

1. Remove all traces of curing compound from vertical surfaces which are to be painted or coated. Use a stiff broom to remove compound a minimum of fourteen (14) days after application.

B. Horizontal Surfaces:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven (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 12" lap over adjacent absorptive covers
2. Liquid Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Maintain continuity of coating and repair damage during curing period.
 - a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer. Unless manufacture certifies that the curing compound will not interfere with the bonding of floor covering used on the Project.

3.12 REMOVING AND REUSING FORMS

- A. Forms shall be removed in accordance with the following time and strength requirements:
 1. Column forms, wall forms, and other vertical formwork: Three (3) days after casting.
- B. In hot, dry climatic conditions, wood forms remaining in place do not provide adequate curing but should be loosened so that the concrete surfaces can be kept moist by wetting with water. In cold weather, removal of formwork should be deferred or formwork should be replaced with insulation blankets to avoid thermal shock and consequent crazing of the concrete surface.
- C. Remove formwork progressively so no unbalanced loads are imposed on structure.
- D. Do not damage concrete surfaces during form removal. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces.
- E. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.

3.13 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces not exposed to view in the finish work.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Finish shall be as defined in ACI 301. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces exposed to view in the finish work, to receive a rubbed finish, to be covered with a coating or covering material applied directly to the concrete.
- C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:
 - 1. Smooth-Rubbed Finish: Not later than one (1) day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
- D. Architectural Concrete Surfaces: Refer to the architectural drawings and Section 6 of ACI 301. Match approved mock-up.
- E. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.
- F. Maintain uniformity of special finishes over construction joints, unless otherwise indicated.

3.14 EXPOSED AGGREGATE FINISHES

- A. Exposed Aggregate Finish to match historic exposed aggregate finishes on existing structures, to be coordinated with and to match finishes specified within Cast Stone Specifications. Performance of finishing shall be executed so that results match design reference samples and mock-ups as well as retained samples of historic exposed aggregate finishes, as approved by Owner's Representative.
- B. Abrasive Blast Finish: Perform abrasive blasting after compressive strength of concrete exceeds 2000 psi. Coordinate with formwork removal to ensure that surfaces to be abrasive-blasted are treated at the same age for uniform results.
 - 1. Surface Continuity: Perform abrasive blasting in as continuous an operation as possible, maintaining continuity of finish on each surface or

- area of work. Maintain required patterns or variances in depths of blast to match design reference samples and mock-ups.
2. Abrasive Blasting: Abrasive blast corners and edges of surfaces carefully, using back-up boards, to maintain uniform corner or edge line. Determine type of nozzle, nozzle pressure, and blasting techniques required to match design reference samples and mock-ups.
 3. Depth of Cut: Use an abrasive grip of proper type and gradation to expose aggregate and surrounding matrix surfaces to match design reference samples and mock-ups, as follows:
 - a. Light Sand Blast: Expose fine aggregate with occasional exposure of coarse aggregate and uniform color; with maximum reveal of 1/16 inch.
 - b. Medium Sand Blast: Generally expose coarse aggregate; with slight reveal, a maximum of 1/4 inch.

3.15 FINISHING SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, re-straightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4" in one direction.
 1. Apply scratch finish to surfaces to receive a concrete floor topping or mortar setting beds for tile, stone and other bonded applied cementitious finish flooring material.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Re-straighten, cut down high spots, and fill low spots. Repeat float passes and re-straightening until surface is left with a uniform, smooth, granular texture.
 1. Apply float finish to surfaces to receive trowel finish, to be covered with membrane or elastic waterproofing, membrane or elastic roofing, and otherwise indicated.
 2. Float Finish shall be provided for top surfaces of walls and slabs.
- D. Smooth Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and re-straighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 1. Apply a trowel finish where concrete flatwork is to be exposed in the finished work.

- E. Broom Finish: Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.
 - 1. Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.

3.16 SLAB PLACEMENT TOLERANCES

- A. Concrete slabs on grade shall achieve the following tolerances, when measured in accordance with ASTM E1155:
 - 1. Overall Floor Flatness, F_F : 35
 - 2. Minimum Local Floor Flatness, F_F : 20
 - 3. Overall Floor Levelness, F_L : 20
 - 4. Minimum Local Floor Levelness, F_L : 12
- B. Suspended concrete slabs shall achieve the following tolerances, when measured in accordance with ASTM E1155:
 - 1. Overall Floor Flatness, F_F : 35
 - 2. Minimum Local Floor Flatness, FF : 20
- C. Remedial Action: Provide remedial measures for slabs if the measured floor flatness and/or levelness are less than the specified values for the entire floor and for individual sections.

3.17 PROTECTION OF FINISHED WORK

- A. Concrete Protection: Barricade all concrete surfaces immediately after the surfaces are finished. Do not allow any traffic, except for foot traffic; on the concrete surfaces until the concrete has cured seven (7) days or until concrete cylinders have achieved 80% of design strength.
- B. Embedded items: Protect projecting inserts, anchor bolts and other embedded items from disturbances until concrete has sufficiently set to hold such items immovable.
- C. Areas subjected to traffic shall be protected by means of boardwalks.
- D. Protect concrete from damage due to sun, rain, flowing water, frost, weather and mechanical injury.
- E. Maintain concrete temperature at a minimum of 50° F for not less than seven (7) days.
- F. Protect all exterior footings from frost action by backfilling with a minimum of four (4) feet of soil cover above bottom of footings. Protect all interior footings by temporarily insulating, or providing temporary heat until the building is erected, closed to weather, and heated.

- G. Do not backfill against or over any footing or wall until concrete for footing, wall or members they support have reached 80% of design strength as shown by test cylinders, unless otherwise noted.
- H. Keep heavy loads away from any wall until the concrete attains its design strength. Place stake banners to prevent encroachment.
- I. Contractor is responsible for damage to, or misalignment of, walls resulting from earth backfilling, trapped water or other causes.

3.18 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Coordinate sizes and locations of concrete bases with actual equipment provided. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacture furnishing machines or equipment.

3.19 PATCHING AND REPAIR OF CONCRETE

- A. General: As soon as forms are removed, patch and repair tie holes and other surface defects.
- B. If correction of surface defects is required, submit to Engineer measures and methods proposed.
- C. On all exposed concrete walls, the intent of the Specifications is to provide walls which are finished smooth, aesthetically pleasing, uniform in color and appearance and free from depressions, sags, air holes, trowel marks, bumps, projections and other surface imperfections. Should Engineer determine that this intent has not been met, Contractor shall perform all repairs, replacements and corrective work which may be required to attain a finish acceptable to Engineer, including grinding or painting, if necessary.
- D. Preparation: Do not perform any patching until all honeycomb and laitance have been cut out to solid concrete. If chipping is necessary, chip areas to be patched to a depth of at least 1", with edges regular and perpendicular to the surface, or slightly undercut. Thoroughly wet the prepared areas, including the area 6" all around each prepared area, just before applying the patching mortar.
- E. Mortar: Mortar for patching shall be of the same materials and proportions used for the concrete, except that the coarse aggregate shall be omitted and a sufficient amount of white cement shall be substituted for the grey cement in order to produce a patch whose color matches the color of the surrounding surfaces. Mortar shall not be thicker than (1) one part cement to three (3) parts sand. Keep mixing water to a minimum. Re-temper mortar, without addition

of water, by occasional mixing to prevent setting. Using mortar which has begun to set or is more than one (1) hour old is not permitted.

- F. Application of Mortar: Thoroughly compact mortar into place and screed to leave the patch slightly higher than the adjacent surface. Leave undisturbed for one to two hours to permit initial shrinkage before being finally finished to match adjoining work. Patches exceeding 1" in depth shall be filled to within 1" of the surface and, after sufficient time has elapsed for shrinkage, final patching shall proceed. Keep all patches wet for at least five (5) days.
- G. Tie Holes: Except where surfaces will be epoxy coated, solidly fill all holes left by bolts or ties with mortar. Holes passing entirely through the wall shall be filled from the inside face with a device that will force mortar through to the outside face, using a stop held at the outside face to ensure complete filling. Holes not passing entirely through walls shall be packed full. Strike off excess mortar flush with a cloth.

3.20 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspection agency to perform field tests and inspections and prepare test reports.
- B. Inspections:
 - 1. Steel reinforcement placement.
 - 2. Steel reinforcement welding.
 - 3. Headed bolts and studs.
 - 4. Verification of use of required design mixture.
 - 5. Concrete placement, including conveying and depositing.
 - 6. Curing procedures and maintenance of curing temperature.
 - 7. Verification of formwork for shape, location, and dimensions of the concrete members being formed.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C172 shall be performed according to the following requirements:
 - 1. Testing Frequency: Composite samples for each concrete mixture placed each day shall be taken not less than once a day, nor less than once for each 100 cubic yards of concrete or fraction thereof, nor less than once for each 5,000 square feet of surface area for slabs and walls.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 - 2. Slump: ASTM C143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete

- mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C231, pressure method, for normal-weight concrete; ASTM C173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 4. Concrete Temperature: ASTM C1064; one test hourly when air temperature is 40° F and below and when 80° F and above, and one test for each composite sample.
 5. Unit Weight: ASTM C567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 6. Compression-Test Specimens: ASTM C31.
 - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
 7. Compressive-Strength Tests: ASTM C39; test one set of two laboratory-cured specimens at 7-days and one set of two specimens at 28-days.
 - a. A compressive-strength test shall be the average compressive strength from a set of two 6"x12"specimens or three 4"x8"specimens obtained from same composite sample and tested at age indicated.
 8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
 9. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 72 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7-day and 28-day tests.
 10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the Owner's Representative but will not be used as sole basis for approval or rejection of concrete.
 11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42 or by other methods as directed by Engineer.
 12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

14. Measure floor and slab flatness and levelness according to ASTM E115 within 72 hours of finishing.

END OF SECTION

SECTION 034100

ARCHITECTURAL STRUCTURAL PRECAST CONCRETE AND UNIT CAST STONE

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.

1.2 SUMMARY

- A. This Section includes the performance criteria, materials, design, production, and erection of structural precast. The work performed under this Section includes all labor, material, equipment, related services, and supervision required for the manufacture and erection of the structural precast concrete work shown on the Contract Drawings. In addition, this section establishes criteria for materials, mixes and evaluations of Cast Stone (architectural pre-cast concrete with specific finishes that replicate the historic finishes of the existing Tempietto) Dry Tamp Cast Stone, or Vibrant Dry Tamp Cast Stone, or measurable slump cast stone that does not contain large and small aggregate in addition to sand and cement shall not be accepted.
- B. The Work of this Section includes all labor, materials, equipment and services such as field measurements, shop drawings, submittals etc necessary to complete the structural precast and cast stone work as shown on the drawings and specified herein, including but not necessarily limited to the following:
 - 1. A Three-Dimensional model including overall data will be provided to the fabricator. However, the fabricator shall make his or her own model for fabrication of the cast stone units and shall be solely responsible for unit fit-up, dimensional stability and geometric conformity to existing structure.
 - 2. Precast/Cast stone units as indicated on contract drawings to match existing cast stone units in form, color, texture and historic finishes. Finishes vary from heavily exposed aggregate to form finish and include light etching, light blasting, moderate and heavy etching and blasting as well as the use of retarder agents to expose varying levels of aggregate.
 - 3. Precision patterns, forms and molds as required to replicate the dimensions, profiles, surface textures and exposed aggregates of the existing cast stone units in their unweathered or minimally weathered locations. Patterns made from salvaged existing units must be corrected to remove cracks and other defects related to weathering or use.
 - 4. Sculpted patterns to replicate decorative elements must be made to replicate the unweathered appearance of the originals.
 - 5. Dry Fitting of Cast Stone Assemblies: Dry Fit all multipart cast stone assemblies to ensure that units will fit with each other and into existing masonry openings prior to shipping to jobsite. Submit photo-documentation of dry-fitted assemblies showing that the units fit with each other and that all profiles and details are in the proper alignment with ledges, overhangs or misalignments.

ARCHITECTURAL STRUCTURAL PRECAST CONCRETE AND UNIT CAST STONE

C. Terminology:

1. "Architectural Structural Precast" refers to structural precast concrete members that have architectural finishes to match the existing unweathered finishes of the original units.
2. "Cast Stone" refers to measurable slump concrete, self-supporting non-structural precast concrete elements that have architectural finishes to match the existing unweathered finishes of the original units.

This Section includes the following:

3. Architectural Structural Precast concrete dome.
4. Architectural Structural Precast concrete columns and beams.
5. Cast Stone balusters and rails, well with satyr mask.

D. Related Sections include the following:

1. Section 033300 "Architectural Concrete" for installing connection anchors and reinforcing steel in concrete and structural topping.
2. Section 034200 "Installation and Erection of Architectural Structural Precast Concrete" for installation and erection.

1.3 REFERENCES

Cast Stone Institute Technical Manual, current edition

ACI 301 - Structural Concrete for Buildings.

ACI 302 - Guide for Concrete Floor and Slab Construction.

ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.

ACI 305R - Hot Weather Concreting.

ACI 306R - Cold Weather Concreting.

ACI 308 - Standard Practice for Curing Concrete.

ACI 318 - Building Code Requirements for Reinforced Concrete.

ANSI/ASTM D1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

ASTM C33 - Concrete Aggregates.

ASTM C94 - Ready-Mixed Concrete.

ASTM C150 - Portland Cement.

ASTM C260 - Air Entraining Admixtures for Concrete.

ASTM C494 - Chemicals Admixtures for Concrete.

ASTM A 955 / A 955M - Specification for Deformed and Plain Stainless Steel Bars for Concrete Reinforcement

ASTM C 979 - Standard Specification for Pigments for Integrally Colored Concrete.

ASTM C 1194: Compressive strength, 6000 psi minimum for products at 28 days.

ASTM C 1195 or ASTM C 642: Absorption, 6% maximum for products at 28 days.

ASTM C 1364 - Standard Specification for Architectural Cast Stone.

ACI SP-66 - American Concrete Institute - Detailing Manual.

ANSI/ASTM A185 - Welded Steel Wire Fabric for Concrete Reinforcement.

CRSI - Concrete Reinforcing Steel Institute - Manual of Practice.

CRSI - Placing Reinforcing Bars.

1.4 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide structural precast concrete members and connections capable of withstanding design loads indicated within limits and under conditions indicated on Drawings.
- B. Structural Performance: Provide structural precast concrete members and connections capable of withstanding the following design loads within limits and under conditions indicated:
 - 1. All design loads are to be calculated in accordance with "Minimum Design Loads for Buildings and Other Structures (ASCE/SEI 7-10) and 9th edition of The Massachusetts State Building Code.
 - 2. Design structural precast concrete framing system and connections to maintain clearances at openings, to allow for fabrication and construction tolerances, to accommodate live-load deflection, shrinkage and creep of primary building structure, and other building movements. Maintain structural precast concrete deflections within limits of ACI 318 (ACI 318M).

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Retain quality control records and certificates of compliance for 5 years after completion of structure.
- B. Design Mixtures: For each precast concrete mixture. Include compressive strength.
- C. Test Reports: Submit copies of all quality control reports and in house testing produced by the plant during casting of the units for this project. Submit results of in-house testing. Test reports to indicate date of casting, as well as slump, air entrainment, water absorption and compressive strength at 7 and 28 days.
- D. Fabricator to keep, and periodically submit to owner, a list of which units were cast on each day of casting and then indicate the casting date on each of the units.
- E. Shop (Erection) Drawings:
 - 1. Detail fabrication and installation of structural precast concrete units including connections at member ends and to each adjoining member.
 - 2. Indicate locations, plan views, elevations, dimensions, shapes, and cross sections of each unit, openings, support conditions and types of reinforcement, including special reinforcement.

3. Indicate aesthetic intent including joints, rustications or reveals, and extent and location of each surface finish.
4. Detail loose and cast-in hardware, lifting and erection inserts, connections, and joints.
5. Indicate locations, tolerances and details of anchorage devices to be embedded in or attached to structure or other construction.
6. Indicate location of each structural precast concrete member by same identification mark placed on unit.
7. Indicate relationship of structural precast concrete members to adjacent materials.
8. Indicate locations and details of joint treatment.
9. Indicate shim sizes and grouting sequence.
10. Design Modifications: If design modifications are proposed to meet performance requirements and field conditions, notify the Architect and submit design calculations and Shop Drawings. Do not affect the appearance, durability or strength of members when modifying details or materials. Maintain the general design concept when altering size of members and alignment.
11. The shop drawings shall show the setting mark of each unit of cast stone and its location on the structure. The cast stone shall bear the same corresponding setting mark on an unexposed surface.
12. Shop drawings shall show exact profiles for each cast stone unit.
13. Include assembly elevations showing layout of units and locations of joints and anchors.

F. Samples:

1. Submit as many 12" x 12" cast stone samples as required to obtain approval of finishes, exposed aggregate and matching of historic finishes. Show full range of colors and textures proposed to match existing units.
- G. Provide handling procedures, erection sequences, and for special conditions provide temporary bracing and shoring plan.
- H. Comprehensive engineering design (signed and sealed) by a qualified professional engineer responsible for its preparation licensed in Massachusetts.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For [installer] [fabricator] [testing agency] and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include list of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- B. Welding Certificates: Copies of certificates for welding procedure specifications (WPS) and personnel certification.

- C. Material Test Reports for aggregates: From an accredited testing agency, indicating and interpreting test results for compliance with requirements indicated.
- D. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements.
 - 1. Cementitious materials.
 - 2. Reinforcing materials and prestressing tendons.
 - 3. Admixtures.
 - 4. Bearing pads.
 - 5. Structural-steel shapes and hollow structural sections.
 - 6. Insulation.
 - 7. Other components specified in Contract Documents with applicable standards.
- E. Field quality-control test [and special inspections] reports.

1.7 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm that complies with the following requirements and is experienced in producing structural precast concrete units similar to those indicated for this Project and with a record of successful in-service performance.
 - 1. Assumes responsibility for engineering structural precast concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
 - 2. Professional Engineer Qualifications: A professional engineer licensed in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of structural precast concrete that are similar to those indicated for this Project in material, design, and extent.
Participates in PCI's Plant Certification program and is designated a PCI-certified plant for Group C, Category C1 – Precast Concrete Products (no prestressed reinforcement)
 - 3. Has sufficient production capacity to produce required members without delaying the Work.
 - 4. Certification shall be maintained throughout the production of the precast concrete units. Production shall immediately stop if at any time the fabricator's certification is revoked, regardless of the status of completion of contracted work. Production will not be allowed to re-start until the necessary corrections are made and certification has been re-established. In the event certification(s) cannot be re-established in a timely manner, causing project delays, the fabricator, at no additional cost, will contract out the remainder of the units to be manufactured at a PCI certified plant.
 - 5. Is registered with and approved by authorities having jurisdiction.

- B. Testing Agency Qualifications: An independent accredited testing agency qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated.
- C. Design Standards: Comply with ACI 318 (ACI 318M) and the design recommendations of PCI MNL 120, "PCI Design Handbook – Precast and Prestressed Concrete," applicable to types of structural precast concrete members indicated.
- D. Quality-Control Standard: For manufacturing procedures and testing requirements and quality control recommendations for types of members required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Concrete Products."
 - 1. Comply with camber and dimensional tolerances of PCI MNL 135, "Tolerance Manual for Precast and Prestressed Concrete Construction."
- E. Product Options: Drawings indicate size, profiles and dimensional requirements of precast concrete members and are based on the specific types of members indicated. Other fabricators' precast concrete members complying with requirements may be considered. Refer to Division 1 Section "Substitutions."
- F. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel"; AWS D1.4/D1.4M, "Structural Welding Code – Reinforcing Steel"; and AWS D1.6/D1.6M, "Structural Welding Code-Stainless".

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver all structural precast concrete members in such quantities and at such times to assure compliance with the agreed upon project schedule and setting sequence to ensure continuity of installation.
- B. Pack, handle, and ship cast stone units in suitable packs or pallets.
 - 1. Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move cast stone units, if required, using dollies with wood supports.
 - 2. Store cast stone units on wood skids or pallets with non-staining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to units. Ventilate under covers to prevent condensation.
- C. Handle and transport members in a manner to avoid excessive stresses that could cause cracking or other damage.
- D. Store units with adequate dunnage and bracing, and protect units to prevent contact with soil, staining, and to control cracking, distortion, warping or other physical damage.
- E. Protection:
 - 1. Use all means necessary to protect cast stone and related materials before, during and after installation and to protect the installed work and materials of all other trades.
- F. Unless otherwise specified or shown on Shop Drawings, store members with dunnage across full width of each bearing point.

- G. Place stored members so identification marks are clearly visible, and units can be inspected.
- H. Place dunnage of even thickness between each member.
- I. Lift and support members only at designated points indicated on the Shop Drawings.
- J. Replacements: In the event of damage, immediately make all repairs and replacements necessary for Architect's approval, at no additional cost to the Owner.

1.9 SEQUENCING

- A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction without delaying the Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE AND CAST STONE COLOR AND FINISH

- A. The Precast Concrete and Cast Stone used in this work shall match colors, textures and finishes of samples approved by the Architect and shall match the profiles shown on the Drawings. The range of finishes required includes heavily exposed aggregate, moderately exposed aggregate, light sandblast, light etch and form finished.
- B. The samples shall be approved by the Architect before the manufacturer shall be required to proceed with the work.
- C. Finishes for units made under this specification to match historic finishes on existing structures in their unweathered or slightly weathered appearance. Finishes of units identified as structural precast to match the finishes of the units designated as cast stone. In every case the finish and appearance standards of cast stone as defined in the Precast Manual shall govern the appearance of all units manufactured under this specification. Finishes shall be executed so that results match design reference samples and mock-ups as well as retained samples of historic finishes, as approved by Owner's Representative.
- D. Models and Molds
 1. Certain changes in profile, section and wash may be required in the model/pattern phase in order to improve on the durability and water shedding capability of the original units.
 2. All models and patterns shall be prepared by skilled craftsmen in a correct and artistic manner in strict accordance with the spirit and intent of the original units and the contract drawings. Models shall be approved by architect before any work is executed from them.
 3. Provide forms and molds as required to produce finished surfaces. Accurately construct forms that are mortar tight and of sufficient strength to provide cast stone units of shape, lines and sizes shown.
 4. Forms and molds shall be kept in good, re-usable condition for the duration of the casting process.

5. Face on well/fountain to be site molded prior to the demolition of this detail. A pattern is to be cast from the site mold and then corrected by a skilled sculptor. Corrected pattern to be approved by Architect prior to final mold making.
6. Columns to be cast as single, monolithic units. Mold seams to be kept at a minimum.

2.2 FORM MATERIALS

- A. Forms: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that will provide precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required surface finishes.
 1. Form-Release Agent: Commercially produced form-release agent that will not bond with, stain or affect hardening of precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.

2.3 PRECAST CONCRETE AND CAST STONE MATERIALS

- A. General: Comply with ASTM C1364 and the following:
 1. Portland Cement: ASTM C150, Type I White Cement
 2. Fine aggregate shall be carefully graded and washed natural sands, or manufactured granite, marble, quartz or limestone sands meeting ASTM C33, except that gradation may vary to achieve desired finish and texture.
 3. Coarse aggregate shall be carefully graded and washed natural gravel, or crushed graded stone such as granite, marble quartz, limestone or other durable stone meeting ASTM C33, except that gradation may vary to achieve desired finish and texture that matches existing historic cast stone.
 4. Color Admixture: Shall conform to ASTM C979, ACI 303.1, ASTM C494 and ASSHTO M194. Color Admixture for integrally colored concrete shall be synthetic mineral-oxide pigment or colored water-reducing admixture; color stable, nonfading, and resistant to lime and other alkalis.
 - a. Color: As selected by the Owner's Representative from manufacturer's full range. Color Admixture shall be selected in order to match historic exposed aggregate finishes on existing structures, to be coordinated with and to match finishes specified within Cast Stone Specifications. Performance of finishing shall be executed so that results match design reference samples and mock-ups as well as retained samples of historic exposed aggregate finishes, as approved by Owner's Representative.
 5. Air-Entraining Admixture: ASTM C260, certified by the manufacturer to be compatible with other admixtures used.
 - a. Add to mixes for units exposed to the exterior at manufacturer's prescribed rate to result in an air content of 5 to 7 percent.

2.4 PRECAST CONCRETE AND CAST STONE UNITS

- A. Precast Concrete and Cast Stone units shall exactly match and replicate the concrete elements that they are replacing. Measure and document existing units as needed to produce re-usable forms for casting of each component. Match aggregate and paste color and make-up of existing units to provide, color, texture and appearance of the original units in their un-weathered form.
- B. Provide Precast Concrete and Cast Stone units complying with ASTM C1364.
 - 1. Provide units that are resistant to freezing and thawing as determined by laboratory testing according to ASTM C666, procedure, as modified by ASTM C1364.
- C. All Precast Concrete and Cast Stone used in this work shall have a minimum compressive strength of six thousand (6,000) lbs. per square inch and absorption of not greater than five (5) percent when tested in accordance with ACI 704.
- D. Absorption: 6 percent maximum at 28 days, per ASTM C 1195 or ASTM C 642.
- E. Reinforce units as indicated and as required by ASTM C1364. Use epoxy-coated, galvanized or stainless steel reinforcement. Provide reinforcement of at least 0.25% of cross-sectional area in any direction exceeding 12" in length.
- F. Fabricate units with sharp arris and details accurately reproduced with indicated texture on all exposed surfaces, unless otherwise indicated.
 - 1. Slope exposed horizontal surfaces at least 1:12, unless otherwise indicated.
 - 2. Provide drips on projecting elements, unless otherwise indicated.
- G. Casting Tolerances: Maintain casting, bowing, warping and dimension tolerance to within the following:
 - 1. Overall dimension for height, width and length of units: Plus zero of unit dimension to minus 1/8" in each direction.
 - 2. Bowing or warping: Not to exceed 1/360 of the span.

2.5 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A216, type 316 or 2205, deformed per ASTM A955.

2.6 CONCRETE MATERIALS

- A. Regional Materials: Precast structural concrete shall be manufactured from aggregates[and cement] that have been extracted or recovered, as well as manufactured, within 500 miles (800 km) of Project site.
- B. Portland Cement: ASTM C 150/C 150M, Type I or Type III, gray, unless otherwise indicated.
 - 1. For surfaces exposed to view in finished structure, use gray or white cement, of same type, brand, and mill source.

- C. Supplementary Cementitious Materials:
1. Retain mineral or cementitious admixtures in first four subparagraphs below. Because fly ash and gray silica fume affect color uniformity, they are not recommended by PCI where appearance is important. White silica fume is available.
 2. Fly Ash: ASTM C 618, Class C or F, with maximum loss on ignition of 3 percent.
 3. Metakaolin: ASTM C 618, Class N.
 4. Silica Fume: ASTM C 1240, with optional chemical and physical requirement.
 5. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
 6. Retain "Blended Hydraulic Cement" Subparagraph below if factory-blended hydraulic cement is permitted; verify availability of options before specifying. Fly ash, slag, or pozzolanic materials in the nonportland cement part of blended hydraulic cement may slow rate of concrete strengthening and affect color uniformity.
 7. Blended Hydraulic Cement: ASTM C 595/C 595M.
- D. Normal-Weight Aggregates: Except as modified by PCI MNL 116, ASTM C 33/C 33M. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.
1. Face-Mixture-Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match selected finish sample.
 - a. Retain one option in "Gradation" Subparagraph below or insert gradation and maximum aggregate size if known. Fine and coarse aggregates are not always from same source.
 2. Gradation: To match design reference sample. Maximum size aggregate shall be 3/4 inch (19 mm) for the fascia wythe concrete. This size constitutes an economical mix that can be pumped if desired. Larger size aggregate impedes placement.
 3. Face-Mixture-Fine Aggregates: Selected, natural or manufactured sand compatible with coarse aggregate to match approved finish sample.
- E. Lightweight Aggregates: Except as modified by PCI MNL 116, ASTM C 330/C 330M, with absorption less than 11 percent.
- F. Coloring Admixture: ASTM C 979/C 979M, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading.
- G. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 116.
- H. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

- I. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.
 1. Retain one or more chemical admixtures in nine admixture subparagraphs below if chemical admixtures are permitted; limit chemical admixture types if required. Water-reducing admixtures, Types A, D, and E, or a high-range water reducer, Type F, predominate.
 2. Water-Reducing Admixtures: ASTM C 494/C 494M, Type A.
 3. Retarding Admixture: ASTM C 494/C 494M, Type B.
 4. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 5. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.
 6. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 7. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 8. Plasticizing Admixture: ASTM C 1017/C 1017M, Type I.
 9. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
 10. Corrosion-Inhibiting Admixture: ASTM C 1582/C 1582M.

2.7 STAINLESS-STEEL CONNECTORS AND MATERIALS

- A. Stainless-Steel Plate: ASTM A 666, Type 316.
- B. Stainless-Steel Bolts and Studs: ASTM F 593, alloy 316, hex-head bolts and studs; stainless-steel nuts; and flat, stainless-steel washers.
 1. Lubricate threaded parts of stainless steel bolts with an anti-seize thread lubricant during assembly.
- C. Erection Accessories: Provide clips, hangers, high density plastic or steel shims, and other accessories required to install structural precast concrete members.
- D. Welding Electrodes: Comply with AWS standards for steel type and/or alloy being welded.
- E. CINTEC Anchor Rods (where indicated on the Contract Drawings as "Cintec Anchors"): as detailed, manufactured and supplied by CINTEC America Inc. available through Conspec Associates in East Haven, CT.

2.8 GROUT MATERIALS

- A. Sand-Cement Grout: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144, or ASTM C 404. Mix at ratio of 1 part cement to 2 ½ to 3 parts sand, by volume, with minimum water required for placement and hydration. Water-soluble chloride ion content of grout less than

0.06 percent chloride ion by weight of cement when tested in accordance with ASTM C 1218/C 1218M. Grout shall contain the following:

1. White or gray Portland cement plus mineral oxide pigments at up to 6% of cement by volume as needed to match the paste color of the Precast Concrete and Cast Stone.
2. Fine aggregate and "seeded" coarse aggregate to match the aggregate of the Precast Concrete and Cast Stone in surface appearance.
3. Superplasticizer as needed for flow.
4. Shrinkage compensator in proper dosage to eliminate curing shrinkage.
5. Air entrainment admixture.

Submit a proposed mix design and acid-washed in-place samples in direct contact with samples of Precast Concrete and Cast Stone.

2.9 CONCRETE MIXTURES

- A. Prepare design mixtures for each type of precast concrete required.
 1. Limit use of fly ash to 35 percent replacement of portland cement by weight; granulated blast-furnace slag to 50 percent of portland cement by weight; and metakaolin and silica fume to 10 percent of portland cement by weight.
- B. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at structural precast concrete fabricator's option.
- C. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 (ACI 318M) or PCI MNL 116 when tested in accordance with ASTM C 1218/C 1218M.
- D. Normalweight Concrete Mixtures: Proportion mixtures by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normalweight concrete with the following properties:
 1. Compressive Strength (28 Days): 5000 psi (34.5 Mpa) minimum.
 2. Release Strength: as required by design.
 3. Maximum Water-Cementitious Materials Ratio: 0.45.
- E. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 116.
- F. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.
- G. Concrete Mixture Adjustments: Concrete mixture design adjustments may be proposed if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

2.10 FORM FABRICATION

- A. Form: Accurately construct forms, mortar tight, of sufficient strength to withstand pressures due to concrete placement and vibration operations and temperature changes, and for prestressing and detensioning operations. Coat contact surfaces of forms with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.
- B. Maintain forms to provide completed structural precast concrete members of shapes, lines, and dimensions indicated in Contract Documents, within fabrication tolerances specified.

2.11 PRE-CAST CONCRETE AND CAST STONE FABRICATION

- A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement. Do not relocate bearing plates in members unless approved by Architect.
- B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, hangers, and other hardware shapes for securing precast concrete members to supporting and adjacent construction.
- C. Cast-in reglets, slots, and other accessories in structural precast concrete members as indicated on Contract Drawings.
- D. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.
 - 1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy coated reinforcing exceeds limits specified in ASTM A 775/A 775M, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
 - 2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Locate and support reinforcement by plastic tipped or corrosion resistant metal or plastic chairs, runners, bolsters, spacers, hangers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.
 - 3. Place reinforcing steel and to maintain at least $\frac{3}{4}$ in. (19 mm) minimum concrete cover. Provide cover requirements in accordance with ACI 318 (ACI 318M) when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
 - 4. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces in accordance with ACI 318 (ACI 318M) and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.
- E. Reinforce structural precast concrete members to resist handling, transportation, and erection stresses, and specified in-place loads, whichever governs.

1. Recess strand ends and anchorages exposed to view a minimum of 1 inch (25 mm), fill with non-metallic, non-shrink mortar and sack rub surface. Coat or spray the inside pocket surfaces with a bonding agent before installing mortar.
- F. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.
- G. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete members.
 1. Place backup concrete to ensure bond with face-mixture concrete.
- H. Thoroughly consolidate placed concrete by vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 116.
 1. Place self-consolidating concrete without vibration in accordance with PCI TR-6 "Interim Guidelines for the Use of Self-Consolidating Concrete." If face and backup concrete is used, ensure adequate bond between concrete mixtures.
- I. Comply with PCI MNL 116 procedures for hot and cold-weather concrete placement.
- J. Identify pickup points of precast concrete members and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast concrete member on a surface that will not show in finished structure.
- K. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using live steam or radiant heat and moisture. Cure members until compressive strength is high enough to ensure that stripping does not have an effect on the performance or appearance of final product.
- L. Fabricate structural precast concrete members of shapes, lines and dimensions indicated, so each finished member complies with PCI MNL 135 product tolerances as well as position tolerances for cast-in items.

2.12 CAST-STONE FABRICATION

- A. Cast stone shall be cured in a totally enclosed curing room or if weather permits; yard cure.
- B. Yard cure units until the sum of the mean daily temperatures for each day equals or exceeds 350 deg F.
- C. Acid etch or lightly sandblast units to remove cement film from exposed surfaces to achieve desired finish.
- D. Cast stone shall have sharp arrises to match profiles on approved shop drawings. Provide stone with sinkages to receive anchors.

2.13 FINISHES

- A. Finishes for units made under this specification to match historic finishes on existing structures in their unweathered or slightly weathered appearance. Finishes of units identified as structural precast to match the finishes of the units designated as cast stone. In every case the finish and appearance standards of cast stone as defined in the Precast Manual shall govern the appearance of all units manufactured under this specification. Finishes shall be executed so that results match design reference samples and mock-ups as well as retained samples of historic finishes, as approved by Owner's Representative.

2.14 SOURCE QUALITY CONTROL

- A. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL 116 requirements. If using self-consolidating concrete also test and inspect according to PCI TR-6 "Interim Guidelines for the Use of Self-Consolidating Concrete" and ASTM C 1611/C 1611M, ASTM C 1712, ASTM 1610/1610M, and ASTM C 1621/C 1621M.
- B. In addition to PCI Certification, Owner will employ an accredited independent testing agency to evaluate structural precast concrete fabricator's quality-control and testing methods.
 - 1. Allow Owner's testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with Owner's testing agency and provide samples of materials and concrete mixtures as may be requested for additional testing and evaluation.
- C. Strength of precast concrete members will be considered deficient if units fail to comply with ACI 318 (ACI 318M) concrete strength requirements.
- D. Testing: If there is evidence that strength of precast concrete members may be deficient or may not comply with ACI 318 (ACI 318M) requirements, fabricator shall employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42/C 42M and ACI 318/ACI 318M.
 - 1. Test results shall be reported in writing on the same day that tests are performed, with copies to Architect, Contractor, and precast concrete fabricator. Test reports shall include the following:
 - a. Project identification name and number.
 - b. Date when tests were performed.
 - c. Name of precast concrete fabricator.
 - d. Name of concrete testing agency.
 - e. Identification letter, name, and type of precast concrete member(s) represented by core tests; design compressive strength; type of failure; actual compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.

- E. Patching: If core test results are satisfactory and precast concrete members comply with requirements, clean and dampen core holes and solidly fill with precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.
- F. Acceptability. Structural precast concrete members that do not comply with acceptability requirements in PCI MNL 116, including concrete strength, and manufacturing tolerances, are unacceptable. Chipped, spalled or cracked members may be repaired. Replace unacceptable units with precast concrete members that comply with requirements.

PART 3 - EXECUTION

- 3.1 See Section 034200 "Installation and Erection of Architectural Structural Precast Concrete" for installation and erection.

END OF SECTION

SECTION 034200

INSTALLATION AND ERECTION OF ARCHITECTURAL STRUCTURAL PRECAST CONCRETE

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.

1.2 SUMMARY

- A. This Section includes the performance criteria, materials, design, production, and erection of structural precast. The work performed under this Section includes all labor, material, equipment, related services, and supervision required for the manufacture and erection of the structural precast concrete work shown on the Contract Drawings.
- B. Terminology:
 - 1. "Architectural Structural Precast" refers to structural precast concrete members that have an architectural finish.
 - 2. "Cast Stone" refers to self-supporting non-structural precast concrete elements that have an architectural finish.
- C. This Section includes the following:
 - 1. Architectural Structural Precast concrete dome.
 - 2. Architectural Structural Precast concrete columns and beams.
 - 3. Cast Stone balusters and rails.
- D. Related Sections include the following:
 - 1. Section 033300 "Architectural Concrete" for installing connection anchors and reinforcing steel in concrete and structural topping.
 - 2. Section 031400 "Architectural Structural Precast Concrete and Unit Cast Stone" for fabricating precast concrete and cast stone units.

1.3 REFERENCES

PCI - Erection Safety for Precast and Prestressed Concrete, 2nd Edition (MNL-132-12)

PCI - Erector's Manual - Standards and Guidelines for the Erection of Precast Concrete Products (MNL-127-99)

INSTALLATION AND ERECTION OF ARCHITECTURAL STRUCTURAL PRECAST CONCRETE

1.4 PREINSTALLATION MEETINGS

- A. Retain "Preinstallation Conference" Paragraph below if Work of this Section is extensive or complex enough to justify a conference.
- B. Preinstallation Conference: Conduct conference at Larz Anderson Park, Brookline MA.

1.5 ACTION SUBMITTALS

- A. Provide handling procedures, erection sequences, and for special conditions provide temporary bracing and shoring plan.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For [installer] [fabricator] [testing agency] and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include list of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- B. Welding Certificates: Copies of certificates for welding procedure specifications (WPS) and personnel certification.
- C. Field quality-control test [and special inspections] reports.

1.7 QUALITY ASSURANCE

- A. Erector Qualifications: A precast concrete erector Qualified by the Precast/Prestressed Concrete Institute (PCI) prior to beginning work at the jobsite. Submit a current Certificate of Compliance furnished by PCI designating qualification in Category S2 (Complex Structural Systems) for load-bearing members].
- B. Erector Certification: A precast concrete erector with erecting organization and all erecting crews Certified and designated, prior to beginning work at project site, by PCI's Certificate of Compliance to erect Category S2 (Complex Structural Systems) for load-bearing members).
- C. Erector Qualifications: A precast concrete erector who has retained a PCI Certified Field Auditor, at erector's expense, to conduct a field audit of a project in the same category as this Project prior to start of erection. Submits Erectors' Post Audit Declaration.
- D. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel"; AWS D1.4/D1.4M, "Structural Welding Code – Reinforcing Steel"; and AWS D1.6/D1.6M, "Structural Welding Code-Stainless".
- E. Preinstallation Conference: Conduct conference at Larz Anderson Park in Brookline MA to comply with requirements in Section 01310 "Project Management and Coordination."

1.8 STORAGE, AND HANDLING

- A. Deliver all structural precast concrete members in such quantities and at such times to assure compliance with the agreed upon project schedule and setting sequence to ensure continuity of installation.
- B. Pack, handle, and ship cast stone units in suitable packs or pallets.
 - 1. Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move cast stone units, if required, using dollies with wood supports.
 - 2. Store cast stone units on wood skids or pallets with non-staining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to units. Ventilate under covers to prevent condensation.
- C. Handle and transport members in a manner to avoid excessive stresses that could cause cracking or other damage.
- D. Store units with adequate dunnage and bracing, and protect units to prevent contact with soil, staining, and to control cracking, distortion, warping or other physical damage.
- E. Protection:
 - 1. Use all means necessary to protect cast stone and related materials before, during and after installation and to protect the installed work and materials of all other trades.
- F. Unless otherwise specified or shown on Shop Drawings, store members with dunnage across full width of each bearing point.
- G. Place stored members so identification marks are clearly visible, and units can be inspected.
- H. Place dunnage of even thickness between each member.
- I. Lift and support members only at designated points indicated on the Shop Drawings.
- J. Replacements: In the event of damage, immediately make all repairs and replacements necessary for Architect's approval, at no additional cost to the Owner.

1.9 SEQUENCING

- A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction without delaying the Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 - PRODUCTS

- 2.1 Where joints are indicated to be grouted provide non-shrink grout: ASTM C1107, CRD C621, pre-mixed grout, non-metallic. Grout strength shall be 3,000 psi at 7-day and 5,000 psi at 28-day and shall be amended with mineral oxide-based pigments as well as aggregates in order to match architectural structural cast stone units where exposed.
- 2.2 For all other joints, not indicated to be grouted, provide ASTM C270, type M mortar that usually matches structural architectural precast in order to fully bed all components.
- 2.3 See section 034100 "Architectural Structural Precast Concrete and Unit Cast Stone" for product information not shown herein.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Furnish loose connection hardware and anchorage devices for precast concrete members to be embedded in or attached to the building structural frame or foundation before starting that Work. Provide locations, setting diagrams, templates and instructions for the proper installation of each anchorage device.
- B. Clean cast stone before setting by thoroughly scrubbing with fiber brushes followed by a through drenching with clear water. Use only mild cleaning compounds that contain no caustic chemicals.

3.2 EXAMINATION

- A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, bearing surface tolerances, and other conditions affecting precast concrete performance.
- B. Proceed with precast concrete installation only after unsatisfactory conditions have been corrected.
- C. Contractor shall notify precast concrete erector that supporting cast-in-place concrete foundation and building structural framing has attained minimum allowable design compressive strength or supporting steel or other structure is structurally ready to receive loads from precast concrete members prior to proceeding with installation.

3.3 ERECTION

- A. Install loose clips, hangers, bearing pads, and other accessories required for connecting structural precast concrete members to supporting members and backup materials.
- B. Erect structural precast concrete level, plumb and square within the specified allowable erection tolerances. Provide temporary structural framing, shoring and bracing as required to maintain position, stability, and alignment of members until permanent connections are completed.

1. Install temporary steel or plastic spacing shims or bearing pads as precast concrete members are being erected. Surface weld steel shims to each other to prevent shims from separating.
 2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
 3. Remove projecting lifting devices and use plastic patchcaps or sand-cement grout to fill voids within recessed lifting devices flush with surface of adjacent precast concrete surfaces when recess is exposed.
 4. Unless otherwise indicated provide uniform joint widths of $\frac{3}{4}$ in. (19 mm).
- C. Connect structural precast concrete members in position by bolting, welding, grouting, or as otherwise indicated on approved Shop (Erection) Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and/or grouting are completed.
- D. Welding: Comply with applicable AWS D1.1/D1.1M, AWS D1.4/D1.4M and AWS D1.6/D1.6M requirements for welding, welding electrodes, appearance of welds, quality of welds, and methods used in correcting welding work.
1. Protect structural precast concrete members and bearing pads from damage during field welding or cutting operations and provide noncombustible shields as required.
 2. Welds not specified shall be continuous fillet welds, using not less than the minimum fillet as specified by AWS D1.1/D1.1M, D1.4/D1.4M or D1.6/D1.6M.
 3. Clean-weld-affected metal surfaces with chipping hammer followed by brushing or power tool cleaning and then re-prime damaged painted surfaces in accordance with manufacturer's recommendations.
 4. For galvanized metal, clean weld affected metal surfaces with chipping hammer followed by brushing or power tool cleaning, and apply a minimum 0.004 inch (4 mil) thick coat of galvanized repair paint to galvanized surfaces in conformance with ASTM A 780/A 780M.
 5. Visually inspect all welds critical to precast concrete connections. Visually check all welds for completion and remove, reweld or repair all defective welds, if services of AWS-certified welding inspector are not furnished by Owner.
- E. At bolted connections, use upset threads, thread locking compound or other approved means to prevent loosening of nuts after final adjustment.
1. Where slotted connections are used, verify bolt position and tightness at installation. For sliding connections, properly secure bolt but allow bolt to move within connection slot.
 2. For slip critical connections, one of the following methods shall be used to assure proper bolt pretension:
 - a. Turn-of-Nut – in accordance with AISC.
 - b. Calibrated Wrench – in accordance with AISC.
 - c. Twist-off Tension Control Bolt – meeting ASTM F 1852.
 - d. Direct-Tension Control Bolt – meeting ASTM F 1852.

3. For slip critical connections, the method to be used and the inspection procedure to be used shall be approved by the Architect and coordinated with the inspection agency.
- F. Grouting or Dry-Packing Connections and Joints: Indicate joints to be grouted and any critical grouting sequences on Shop (Erection) Drawings. Grout open spaces at keyways, connections and joints where required or indicated. Provide reinforcing steel where indicated. Retain flowable grout in place until it gains sufficient strength to support itself. Fill joints completely without seepage to other surfaces. Alternatively, pack spaces with stiff dry pack grout material, tamping until voids are completely filled. Place grout and finish smooth, level, and plumb with adjacent concrete surfaces. Promptly remove grout material from exposed surfaces before it affects finishes or hardens. Keep grouted joints damp for at least 24 hours after initial set.
1. Trowel top of grout joints on roofs smooth to prevent any unevenness that might interfere with placing of, or cause damage, to insulation and roofing. Finish transitions due to different surface levels not steeper than 1 to 12.
- G. Field cutting of precast, prestressed concrete members is not permitted without approval of the Engineer.
- H. Fasteners: Do not use drilled or power-actuated fasteners for attaching accessory items to precast concrete members unless approved by Precast Engineer and Engineer of Record.
- I. Install Cintec Anchors in accordance with the following:
1. Coordinate design and installation of Cintec anchoring system with manufacturer.
 2. Forward contract drawings, required load information and description of conditions to a representative of Cintec America, Inc. and arrange site visit to observe existing conditions and review installation.
 3. Cintec America shall provide written verification of design load and installation and shall provide additional installation requirements and instructions. Submit to Engineer for review before proceeding with installation. Adjustments shall be made if necessary to the anchor design at no additional cost to the owner but no adjustments shall be made in diameter of rod nor reduction in embedment.
 4. Satisfy Cintec contractor training and certification requirements and successfully complete at least 4 trial anchor installations in field satisfaction of a qualified Cintec representative (unless more are required to obtain certification).
 5. Successful trial installations may be used as permanent installations.
 6. Install anchors in arrangement indicated on the contract drawings and by the size indicated on the contract drawings and verified or modified by the manufacturer in accordance with the approved procedures. Coordinate anchor rod installation and layout with layout and installation of connected elements and within required tolerances. Cut-off or remove grouting ports following installation.
 7. Fill any exposed installation holes in exterior stone units in accordance with the requirements of this section.

3.4 EXPOSED AGGREGATE FINISHES

- A. Exposed Aggregate Finish to match historic exposed aggregate finishes on existing structures, to be coordinated with and to match finishes specified within Cast Stone Specifications. Performance of finishing shall be executed so that results match design reference samples and mock-ups as well as retained samples of historic exposed aggregate finishes, as approved by Owner's Representative.

3.5 ERECTION TOLERANCES

- A. Erect structural precast concrete members level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135. Level out variations between adjacent members by jacking, loading, or any other feasible method as recommended by the fabricator and acceptable to the Architect.

3.6 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections and prepare reports:
 - 1. Erection of load-bearing precast concrete members.
 - 2. Erection of cast stone units
- B. Testing: Owner will engage accredited independent testing and inspecting agency to perform field tests and inspections and prepare reports.
 - 1. Field welds will be subject to visual inspections and dye penetrant or magnetic particle testing in accordance with ASTM E 165 or ASTM E 1444. Testing agency shall be qualified in accordance with ASTM E543.
 - 2. Testing agency will report test results promptly and in writing to Contractor and Architect.
- C. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.
- D. Additional testing and inspecting, at Erector's expense, will be performed to determine compliance of corrected work with specified requirements.

3.7 REPAIRS

- A. Repairs will be permitted provided structural adequacy, serviceability and durability of members and appearance are not impaired.
- B. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A 780/A 780M.
- C. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.
- D. Remove and replace damaged structural precast concrete members when repairs do not comply with specified requirements.

3.8 CLEANING

- A. Clean mortar, plaster, fireproofing, weld slag, and any other deleterious material from concrete surfaces and adjacent materials immediately.
- B. Clean exposed surfaces of precast concrete members after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.
 - 1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's recommendations. Protect adjacent work from staining or damage due to cleaning operations.
 - 2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION

SECTION 044000
STONE ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and relevant sections of these Specifications, apply to the work specified in this Section.

1.2 SUMMARY

- A. Installation of a stone accent band on Architectural Structural Precast Concrete and Cast Stone unit construction.

1.3 REFERENCES

- A. Comply with the following standard material specifications:
 1. ASTM C33 - Concrete Aggregates
 2. ASTM C144 - Sand for Mortar and Grout
 3. ASTM C270 - Mortar and Mortar Testing for Unit Masonry
 4. ACI 301 - Concrete Mix Design and Placement
 5. ACI 318 - Building Code Requirements for Reinforced Concrete for Buildings

1.4 SUBMITTALS

- A. Submit the following items to the Engineer for review:
 1. Test reports required as per paragraph 1.5 - Quality Control.
 2. Samples of new structural pointing and patching mortars and grouts cured in same fashion as will be applied to structure.
 3. Four completed hole and plug mortar applications to simulate completed retrofit facing tie installations.
 4. Samples of new granite units that match type, size and color range of existing with at least (5) samples of each variety.

1.5 QUALITY CONTROL

- A. During periods of cold or questionable weather, keep a log of work including air temperature and weather conditions, work started and completed per day, and tests taken. No work shall be done when the ambient temperature of the structure or the air is less than 45 degrees F.
- B. Produce mortar and grout samples in the form of 2" x 2" x 2" flat slabs, placed against wooden side forms and backing, for easy removal of cured sample. Provide 8 samples per mortar and grout type taken on different days and cured under conditions that match field conditions to

testing laboratory for compression testing. Provide at least four 2" x 2" x 2" field cut samples of existing mortar to the testing laboratory for comparative compression testing. Contractor shall arrange for and pay for all testing and shall submit results at 7 days and at 28 days to the Engineer. Adjustments in mix and re-tests shall be made as required at no additional cost to the owner. Test existing mortar samples and trial mixes at least three weeks before commencing masonry work.

- C. Masonry Contractor shall be a qualified, well-referenced brick and stone mason with at least 10 years of experience in stone construction, repair, and restoration.

PART 2 - PRODUCTS

2.1 MATERIALS AND PRODUCTS

- A. Portland Cement: Type 1 white and/or gray cement as follows: ASTM C150 complying with staining requirements of ASTM C91 for not more than 0.03% water soluble alkali. Mortar shall show no efflorescence when cast in a 2" x 7" x 1/2" slab consisting of 1 part of the cement to be used, 2 parts Ottawa plastic mortar sand and distilled water, and subjected to a 7 day "wick test" conforming to ASTM C67.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Fine Aggregate / Sand:
 - 1. Sand for mortar and grout: ASTM C144, washed. "Bulk" or moisten sand before mixing with binder (proportions based on damp sand).
 - a. Sand for use in exterior-exposed pointing or re-pointing mortar and for plug and filler mortar shall be an approved sand that is reddish in color.
 - 2. For surface fill: Clean, fine sand free of salts.
- D. Stone: New granite units to match color, size, distribution and blend of the existing granite band.
- E. Provide mortar materials as referenced from the Drawings and the uses by type a listed below.
 - 1. Provide the following:
 - a. Mortar for stone setting and exposed exterior pointing and repointing shall be 1 part Portland Cement, 0.25 part Hydrated Lime and 3.5 to 4 parts bulked Sand. Aggregate shall be a combination of properly blended sand and pigments (if necessary) to match the appearance, color and texture of the original pointing mortar. Pigments shall be chemically pure mineral oxides, alkali proof and light fast, and shall be equal or equivalent to "Solomon Grind" as manufactured by Chem Services Inc, of Springfield, IL.
- F. Mortar Washdown Cleaner: "Sureclean 600" as manufactured by ProSoCo Corp.
- G. Steel Stone Ties- Stainless steel ties equal or equivalent to ties manufactured by Hohmann and Barnard.

H. Sealant and Backer Rods

1. Provide closed cell backer rod at all sealant joints. Backer rod shall be carefully sized per sealant manufacturer instructions for each joint.
2. Provide 2-component polyurethane complying with ASTM C-920 and Federal Specification TT-S-00227E.
3. Acceptable manufacturers: Equal or equivalent to Sika, Tremco product line.

PART 3 - EXECUTION

3.1 SETTING OF STONE BAND

- A. Install stone ties at proper alignments and distribution.
- B. At head joints, fill the gaps between stone ends solidly with mortar, Add slate shims if greater than 1" thickness, in order to minimize shrinkage and sloughing.
- C. At bonded collar joints, hand rub a mortar paste slurry over the contact surfaces of the stone to be set and pre-butter depressions which are deeper than 1/4" to provide a non-concave surface. After setting and adjusting the stone units, pack bonded collar joints with mortar.
- D. Stones shall be re-set to within 1/4" of their previous positions and surface alignment, with individual joints' widths along all sides within 1/8" of their cumulative average width per stone.
- E. Strike outer joints at a recessed depth of 2 1/2 times the joints' widths from the surrounding masonry and provide dovetail transitions to existing surrounding joints and to those that are to be re-pointed or removed.
- F. Finish point outer surfaces of the joints to match surrounding work after not less than 24 hours from the setting of the stones and filling of the joints.
- G. Work under this subsection shall only be done when the ambient air, material, and substrate temperatures are above 40 degrees F. by 9:00 AM and rising.

3.2 CLEANING AND PROTECTION OF COMPLETED MASONRY WORK

- A. As work proceeds and upon completion, remove excess mortar, smears and droppings. Clean adjacent and adjoining surface of marks arising out of execution of work in this Section.
- B. Sweep up and remove daily sand, cleaning compounds and mixtures, dirt, debris and rubbish. Sweep or flush away nightly, all residual washed materials. Keep the premises neat and clean at all times.
- C. After installation and pointing are completed, carefully clean all surfaces of all dirt, excess mortar, grout splatter, stains and/or other site incident defacements. Clean soiled surfaces using a non-acidic solution that will not harm stone or adjacent materials. Consult stone fabricator for acceptable cleaners. Do not use wire brushes, acid or other solutions which may cause

discoloration. Use nonmetallic tools in cleaning operation. Apply in accordance with cleaner manufacturer recommendations.

3.3 INSTALLATION OF FLEXIBLE SEALANTS

- A. Provide backer rod and sealant where indicated on the Contract Drawings.
- B. Install backer rod and sealant in strict accordance to manufacturer's instructions. Use primer where recommended by manufacturer.
- C. Size backer rod for each joint size.
- D. Install sealant to the depth recommended by the manufacturer for each width of joint. Joint profile shall match adjoining mortar profile. Face of joint shall be sanded so that color and texture shall match adjoining mortar joints.
- E. Sealant at backer rod shall be installed at all locations indicated on Drawings and at all locations subject to structural or thermal movement.

END OF SECTION

SECTION 055000

METAL FABRICATIONS

PART - 1 GENERAL

1.1 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and relevant sections of these Specifications, apply to the work specified in this Section

1.2 SUMMARY

- A. This work shall consist of fabricating and installing the following:

1. Steel handrails at concrete stairs at Bridge
2. Steel guardrails at Bridge with Decorative Panel
3. Steel guardrails at Weir
4. Steel guardrails at Causeway with Scroll

1.3 REFERENCES

- A. American Architectural Manufacturers Association (AAMA):

1. 611 - Voluntary Specification for Anodized Architectural Aluminum.
2. 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Architectural Extrusions and Panels.
3. 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Architectural Extrusions and Panels.
4. 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Architectural Extrusions and Panels.

- B. American Welding Society (AWS):

1. D1.1 - Structural Welding Code - Steel.
2. D1.2 - Structural Welding Code - Aluminum.
3. D1.6 - Structural Welding Code - Stainless Steel.

- C. ASTM International (ASTM):

1. A36/A36M - Standard Specification for Carbon Structural Steel.
2. A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.
3. A48/A48M - Standard Specification for Gray Iron Castings.
4. A108 - Standard Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality.

5. A123/A123M - Standard Specification for Zinc (Hot-Galvanized) Coatings on Iron and Steel Products.
6. A283 - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars.
7. A307 - Standard Specification for Carbon Steel Externally Threaded Standard Fasteners.
8. A354 - Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners.
9. A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
10. A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
11. A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
12. A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
13. A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength, Low-Alloy and High-Strength Low-Alloy with Improved Formability.
14. E985 - Standard Specification for Permanent Metal Railing Systems and Rails for Buildings.

D. Society for Protective Coatings (SSPC) - Painting Manual.

1.4 SYSTEM DESCRIPTION

A. Fabricate guard rails and handrails in accordance with ASTM E985.

1.5 SUBMITTALS AND SAMPLES

A. Submittals for Review:

1. Shop Drawings: Drawings shall show size and thickness of each member, type of material, method of connection and assembly, fabrication and erection tolerances for all connections, cuts, holes, bolts, welds, galvanizing and finishing, and relation to finished grade, as-built conditions, and layout of panels. Submit shop drawings, certifications, product data, etc. as described herein to the Engineer for approval prior to fabrication and installation.

B. The fabricator shall submit a letter detailing the company's history with relevant projects, equipment and facilities, and related work experience of the staff to be assigned to the project.

C. The contractor shall submit one sample panel with end post and finish for each type of handrail, for review and approval by the Owner's Representative prior to beginning work on the rest of the work. If approved, the sample may be incorporated into the final work.

D. Warranty: Provide warranty that all materials furnished and work executed under this Section comply with Specifications and authorized changes.

1.6 QUALITY ASSURANCE

- A. The contractor shall be regularly engaged in the fabrication and installation of decorative metal handrails and shall have completed successfully at least ten comparable projects within the last ten years. The Contractor shall assign mechanics from these earlier applications to this project, of which one will serve as lead mechanic.
- B. Perform all work in accordance with all applicable safety codes, including ASTM and AWS standards, and accessibility codes, including ADA and MAAB (Massachusetts Architectural Access Board).
- C. Contractor's facilities in which the fabrication and finish work shall be done shall meet all state and federal environmental standards.
- D. There shall be a twenty year warranty on galvanizing.
- E. Welding shall be in accordance with the Structural Welding Code of the American Welding Society, AWS D 1.1.
- F. Where structural joints are made by welding, the details of all joints, the techniques of welding employed, the appearance and quality of welds made, and the methods used to correct defective work shall conform to requirements of the AISC and AWS codes.
- G. Welds shall be made only by welders who have previously been qualified by tests as prescribed in AWS "Standard Qualification Procedure" for the type of work required.
- H. Workmanship and finish shall be equal to the best practice of modern shops for each item of work. Metal fabrication shall be accomplished using the highest standards of workmanship. All work shall be executed by experienced metal workers, shall conform to the requirements of the Contract Documents, and meet the following requirements:
 - 1. Individual metal pieces shall be saw cut and carefully fitted together.
 - 2. Sections shall be well formed to shape and size with sharp lines and angles.
 - 3. Exposed surfaces shall have a smooth finish and sharp, well defined lines and arrises.
 - 4. Grind all edges of bars and plates completely free from nicks and machine marks, prior to galvanizing or shop priming.
 - 5. All surfaces and connections of metal items shall be without visible grinding marks, surface differentiation or variation.
 - 6. All fabricated metal items shall be fine sanded throughout to produce a high standard of surface smoothness.
 - 7. Castings shall have sharp corners and edges and shall be clean, smooth and true to pattern.
 - 8. Welding shall be continuous and shall extend for the entire length of the joints except where specifically indicated on the Contract Documents.
 - a. All exposed welds shall be ground smooth.

9. Weld with uncoated wire to prevent flux deposits. If coated wire is used, all flux residue shall be thoroughly removed and bare white metal exposed, prior to galvanization, if applicable. Where overlapping surfaces are welded, seal off contact area by welding all edges around contact area.
 - a. All welds shall be water tight.
 - b. All shop connections shall be full seam welded and ground flush and smooth.
 - c. Where the work of this Section must be attached to other materials or where it must be assembled and installed in the field, Contractor shall cut, drill, punch and ream, countersink and tap, or otherwise provide the required holes in the shop, unless such connections are to be welded. The sizes and locations of all such holes shall be shown on the Shop drawings.
 - d. All materials and workmanship under this Section shall be subject to inspection in the mill, shop or field by the Owner's representative, or by qualified inspectors retained by the Owner. Inspection shall be without expense to the Contractor. However, such inspection, wherever conducted, shall not relieve Contractor of his responsibility to furnish materials and workmanship in accordance with Contract requirements.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver and store work under this Section in a manner to prevent wracking or stress of components, and to prevent mechanical damage or damage by the elements. All stored materials and items shall be protected from weather, careless handling and vandalism.
- B. Items which become rusted or damaged because of non-compliance with these conditions will be rejected and shall be replaced without additional cost to the Owner.
- C. Deliver work to the site in sufficient time to avoid delay in job progress and at such times as to permit proper coordination of the various parts. The Contractor shall be responsible for scheduling the delivery of all items so as to minimize on-site storage time prior to installation.
- D. Deliver bolts and other small items required for erection of work under this Section bundled with their respective items.

1.8 GUARANTEE

- A. The Contractor shall furnish and deliver standard written manufacturer's guarantee in the Owner's name covering all materials and workmanship under this Section, in addition to other liabilities which the Contractor may have by law or other provisions of the Contract Documents.
- B. Supplier shall pay for repairs of any damage to any part of the project caused by defects in his work and for any repair to the materials or equipment caused by

replacement. All repairs are to be done to the satisfaction of the Owner's Representative.

PART - 2 PRODUCTS

2.1 MATERIALS - STEEL

- A. Materials shall be as indicated on the drawings. All stock, bar and tube shall be ASTM A35, hot dip galvanized ASTM A123

2.2 ACCESSORIES

- A. Hardware: Hardware shall be stainless steel.
- B. Anchoring Cement: Non-shrink cementitious type.

2.3 FABRICATION

- A. Fit and shop assemble items in largest practical sections, for delivery to site.
- B. Fabricate items with joints tightly fitted and secured.
- C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- D. Exposed Mechanical Fastenings: Flush countersunk screws or bolts, unobtrusively located, consistent with design of component except where specifically noted otherwise.
- E. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
- F. Conceal fastenings where possible.
- G. Welding
 - 1. Use welds for permanent connections where possible. Grind exposed welds smooth.
 - 2. Tack welds prohibited on exposed surfaces.

2.4 FINISHES

- A. Finish treatment shall be Colorzinq® Coating over galvanized surface as performed by Voigt & Schweitzer (V & S), Taunton, Massachusetts, or approved equal.
- B. Galvanizing and coating operations shall be enclosed inside the same environmentally controlled facility. After galvanizing, the material shall be transported directly into the coating room. Completed material shall be stored under cover until delivery and all material handling shall be done with web slings

or padded forks to minimize any damage to the pieces. Packing of the finished material shall be done so as to protect the paint finish.

- C. Process shall be a "dry kettle" method and shall conform to the ASTM A123 hot dip galvanizing standards. Finisher shall provide galvanizing certifications for all items galvanized.
- D. Finisher shall prepare the galvanized surfaces using the most current ASTM method D 6386-99 as described under Section 5.4.1., consisting of lightly sweep abrading the zinc surface immediately before applying the primer to remove even minute amounts of oxides that have formed within a 12 hour period. This positive action approach to surface preparation is to eliminate any variables associated with a time sensitive surface preparation method. The procedure shall impart a light profile to the zinc thereby improving the adhesion of the primer. Surface preparation shall be followed immediately by the application of the epoxy coat the same day.
- E. An epoxy prime coat shall be applied at 4 – 5 mils DFT followed by a finish urethane coat applied at 2 – 3 mils DFT. When applied to the minimum of 4 mils of hot dip zinc, a total system thickness of 10 – 12 mils shall be achieved. All coats shall be cured by heating in an enclosed paint facility to promote maximum performance of the system. This controlled curing process shall eliminate the variables normally associated with relying on existing ambient drying conditions.
- F. International Paint as provided by V & S or approved equal shall be used. All proposed coatings shall be well below the 3.5 lb./gallon V.O.C. limit. Prime coat shall be V & S Intercure 440® prime coat or approved equal.
- G. Interthane 870® Urethane Finish by V & S or approved equal shall be used. International has a field technician available for our use during startup and throughout the duration of the project as needed.

PART - 3 EXECUTION

3.1 INSTALLATION

- A. Install items in accordance with approved Shop Drawings.
- B. Install components plumb, level, and rigid.
- C. Welding: AWS D1. Grind and fill exposed welds; finish smooth and flush.
- D. Install sleeved components with anchoring cement.
- E. The contractor is responsible for restoring any areas disturbed by handrail installation, including lawns and plant beds.

3.2 ADJUSTING

- A. Clean and touch up damaged paint with same product as applied in shop.

- B. Clean and touch up galvanized coatings at welded and abraded surfaces in accordance with ASTM A780.

END OF SECTION

SECTION 096613.26

RUSTIC TERRAZZO FLOORING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and relevant sections of these Specifications, apply to the work specified in this Section.

1.02 SUMMARY

- A. Section includes cementitious rustic terrazzo, bonded system.
- B. Related Sections and Requirements:
 - 1. Section 024100 Selective Demolition. Colors and finishes of rustic terrazzo flooring shall match colors and finishes of existing, historic terrazzo flooring. Multiple samples of existing, historic terrazzo flooring in each color and finish shall be retained for sourcing of materials and for comparison to reference samples and mock-ups submitted for approval as required by these Specifications.
 - 2. Section 033300 Architectural Concrete, for float finish and expansion joints in concrete substrate slab.
 - 3. Section 321313 Concrete Paving, for expansion joints.

1.03 DEFINITIONS

- A. NTMA: National Terrazzo and Mosaic Association, Inc.
- B. Marble: Metamorphic (recrystallized) limestone, composed predominantly of crystalline grains of calcite or dolomite or both, having interlocking or mosaic texture.
- C. Aggregate: Material other than marble, used in the topping which may include granite, abrasive, quartz, or river gravel only (glass or plastic not acceptable).

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: The General Contractor shall conduct a conference at Project site before Installer begins installation.
 - 1. The General Contractor shall invite Installer, the Landscape Architect, and representatives of the Owner.
 - 2. Review methods and procedures related to terrazzo including, but not limited to, the following:
 - a. Inspect and discuss condition of substrate and other preparatory work performed by other trades.

- b. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
- c. Review terrazzo mixes and patterns.
- d. Review custom terrazzo mixes, designs, and patterns.
- e. Coordination with the Work of other Installers.

1.05 SUBMITTALS

- A. Product Data: Installer shall submit Product Data for each type of product required for installation including:
 1. Strip materials.
 2. Sealer.
 3. Cement.
- B. Shop Drawings: Installer shall prepare and submit Shop Drawings that include plans, elevations, sections, component details, and attachments to other work. Include terrazzo installation requirements. Show layout of the following:
 1. Divider strips.
 2. Expansion-joint strips.
 3. Accessory strips.
 4. Abrasive strips.
 5. Terrazzo patterns.
- C. Samples for Initial Selection: Installer shall prepare and submit three samples, sizes 12 by 12 inches, for each color and type of terrazzo selected by the Installer and Landscape Architect to match existing, historic terrazzo to be replaced. Colors and finishes of rustic terrazzo flooring shall match colors and finishes of existing, historic terrazzo flooring. Multiple samples of existing, historic terrazzo flooring in each color and finish shall be retained for sourcing of materials and for comparison to reference samples and mock-ups submitted for approval as required by these Specifications
- D. Samples for Verification: Installer shall prepare and submit samples for each type, material, color, and pattern of terrazzo and accessory required showing the full range of color, texture, and pattern variations expected. Each terrazzo sample shall be labeled to identify manufacturer's matrix color and aggregate types, sizes, and proportions. Each Sample shall be of same thickness and prepared from same material to be used for the Work, in size indicated below:
 1. Terrazzo: 12 by 12 inch Samples with divider strips 4 inches from each edge.
 2. Accessories: 6 inch long Samples of each type and kind of exposed strip item required.

1.06 INFORMATIONAL SUBMITTAL

- A. Qualification Data: Installer shall submit two copies of qualification data.

1. Include list of projects with photographs indicating name and location of Project, name of Owner, name and contact information for General Contractor, and name and contact information for Landscape Architect.
2. Include letter from NTMA with the name of the Project and name of member, stating current member status.

1.07 CLOSEOUT SUBMITTAL

- A. Maintenance Literature: Submit two copies of maintenance recommendations of NTMA or maintenance product members of NTMA.

1.08 QUALITY ASSURANCE

- A. Acceptable Suppliers: A firm experienced in manufacturing products in accordance with NTMA standards and with a record of successful in-service performance, as well as sufficient production capacity to produce required materials.
- B. Acceptable Installer: A Contractor Member of NTMA whose work has resulted in construction with a record of successful in service performance.
 1. Installer shall have completed terrazzo installations within the past five years of scale and complexity similar to the proposed installation.
- C. Source Limitations for Aggregates: Installer shall obtain each color, grade, type, and variety of granular materials from single source with resources to provide materials of consistent quality in appearance and physical properties.
- D. Mockups: Installer shall construct mockup to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 1. Build mockup as indicated on Drawings.
 2. Mockup shall be a minimum of 50 square feet.
 3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.09 DELIVERY, STORAGE AND HANDLING

- A. Materials shall be delivered to Project site in supplier's original wrappings and containers, labeled with source or manufacturer's name, material or product brand name, and lot number if any.
- B. Materials shall be stored in their original, undamaged packages and containers.
 1. Cement materials shall be stored inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.10 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit terrazzo flooring to be installed according to NTMA standards.

1. Where existing and forecasted weather conditions do not comply with NTMA standards, the General Contractor shall provide enclosure with temporary heat maintained at a minimum of 50 deg F.
 - B. Installer shall protect other adjacent work from water and dust generated by grinding operations.
- 1.11 GUARANTEE
- A. One year from date of substantial completion of Terrazzo installation.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Structural Slab: Include air entraining agent (6 percent air plus or minus 1 percent) for structural slab to minimize freeze thaw cycle damage. Package air entraining cement must not be used.
- B. Cement, Sand, Aggregates, Colorants, Strips shall be selected to match existing, historic terrazzo flooring, and shall be verified with retained samples of existing, historic terrazzo flooring.
- C. Portland cement: ASTM C 150, Type I, to match existing, historic terrazzo flooring
- D. Sand: Coarse, clean, washed, locally available sand.
- E. Marble, Quartz, Granite or Gravel:
 1. Size: Conform to NTMA standards.
 2. Abrasion and Impact Resistance: Not more than 40 percent loss when tested in accordance with ASTM C 131
 3. Chips shall contain no deleterious or foreign matter.
 4. Glass or plastic chips in Portland cement terrazzo mixes will not be acceptable.
- F. Colorant: Alkali-resistant color stable pigments
- G. Strips:
 1. Expansion joints: Zinc with a cap strip top with a depth of 1-1/4 inches.
 - a. Thickness: 1/2 inch maximum
 - b. Color: to be selected from full range of manufacturer's options
 - c. Material: Ethafoam, butyl rubber, or cork
 2. Divider Strips:
 - a. Materials: White alloy of zinc.
 - b. Thickness: 16 gauge.
- H. Curing Materials: Water or polyethylene sheeting.

2.02 MISCELLANEOUS ACCESSORIES

- A. Sealant: Polyurethane with appropriate backer rod.
- B. Sealer: Installer shall provide a penetrating, non-ambering, clear sealer that is chemically neutral; does not impair terrazzo aesthetics or physical properties; is specifically recommended for rustic terrazzo. Sealers shall comply with the following:
 - 1. Solvent Acrylic Type
 - 2. Solvent-Based Sealer Properties: Flashpoint at 95 deg. F according to ASTM D 56.

2.03 MIXES

- A. Terrazzo Selection: Installer shall provide terrazzo mix(es) according to the following:
 - 1. Custom Mix Color and Pattern: Match existing, historic terrazzo flooring. Multiple samples of existing, historic terrazzo flooring in each color and finish shall be retained for sourcing of materials and for comparison to reference samples and mock-ups submitted for approval as required by these Specifications
- B. Proportions:
 - 1. Underbed: One part portland cement to 4 parts coarse sand. Air entrainment agent (6 percent plus / minus 1 percent air).
 - 2. Terrazzo Topping: One 94-lb. bag of portland cement per 200 lb. of aggregate and sufficient potable water to produce a workable mix. Mix with 4-1/2 to 5 gallons of clean water. Depth of topping 1/2 to 3/4 inch, depending on the size of aggregate. Clean white fine sand may be added to mix.
- C. Mixing: Installer shall mix underbed and topping as follows:
 - 1. Underbed:
 - a. Charge and mix sand and Portland cement.
 - b. Add water and mix.
 - 2. Terrazzo Topping:
 - a. Charge and mix aggregate and portland cement.
 - b. Add water and mix to a uniform workable consistency.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. The General Contractor and Landscape Architect shall examine substrates and areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify that concrete surfaces to receive bonded terrazzo flooring are sound, free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil and other contaminants incompatible with terrazzo flooring materials. Concrete substrate shall have a float finish.

2. Structural cracks in substrate will usually be transmitted through topping to surface. Verify location of cracks, if any.

- B. Installer shall proceed with installation only after unsatisfactory conditions, including levelness tolerances, have been corrected.

3.02 PREPARATION

- A. General Contractor shall broom clean area to receive terrazzo to remove loose chips and all foreign matter.

3.03 INSTALLATION

- A. Concrete Underbed:

1. Surface of concrete slab must not be cured with a liquid membrane or contain other additives which could inhibit bond of terrazzo topping.
2. Concrete underbed to receive bonded rustic terrazzo flooring shall not vary more than 1/4 inch from true plane in 10 foot span and shall receive a float finish.
3. Set expansion material around building perimeter, around all column bases, and directly above expansion joints in concrete structural slab.
4. Thoroughly saturate concrete subfloor with water, slush and broom with neat cement paste.
5. Place concrete underbed and screed to an elevation of 1/2- to 3/4-inch below finished surface, depending on size of aggregate.
6. Install divider strips before concrete hardens.

- B. Placing Rustic Terrazzo Topping:

1. Soak underbed surface thoroughly with clean water.
2. Place rustic terrazzo mixture in panels formed by divider strips and trowel mixture to top of strips.
3. Roll and compact surface until all excess cement and water has been extracted.

- C. Finishing: Expose aggregate by hosing, absorbent rolling, or use of a retarder.

- D. Curing: After completing placement of terrazzo and composition has sufficiently set, Installer shall cure the terrazzo topping by flooding with clean water, or covering with polyethylene sheeting.

- E. Cleaning: When topping is sufficiently cured, in the opinion of the Installer, apply cleaner, scrub with a stiff broom to remove all laitance and rinse immediately with clean water to remove all traces of cleaner. Acid wash no sooner than 7 days after installation.

- F. Sealing:

1. Rinse floor with clean water and allow to dry.

2. When floor is thoroughly dry, apply the sealer in accordance with manufacturer's directions for use on rustic terrazzo.

- G. Joint Sealants: Place sealant in joints with backer rod as required.

3.04 REPAIR

- A. Installer shall repair terrazzo areas that evidence lack of bond between topping and underbed according to NTMA's written recommendations.

3.05 PROTECTION

- A. After application of the sealer, the Work shall be ready for final inspection and acceptance by the Owner or his agent.
- B. The General Contractor shall protect the finished floor after the Installer has completed final grinding and applied sealer to terrazzo surfaces.
- C. De-icing chemicals and salt can be injurious to Portland cement surfaces and should not be used on rustic terrazzo.

END OF SECTION

SECTION 131313

MECHANICAL WATER FEATURE SYSTEM

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 SUMMARY

- A. Proposed refurbished Water Feature is a 5-foot (60-inch) diameter basin within circular Tempietto and oculus above (open to atmosphere).
- B. In general, basin shall have approximately 2 inches of water at most at any given time.
- C. Basin outlet is through sidewall and affixed statue fountain (Satyr) back to Pond through runnel steps.
- D. This Section includes the following:
 - 1. Base Bid (Manual System, Open to Rainfall Above)
 - a. Provide Manual Drain and Valve System to drain Water Feature Basin.
 - b. Provide Emergency Overflow Sidewall Drain connected to Manual Drain System.
 - c. Provide Manual Drain and Valve System to Allow for Continuous Flow through Satyr.
 - 2. Add Alternate Bid #2
 - a. Provide Pond Pumping System to draw water through proposed floating intake to be placed at pond center (near existing aerator).
 - b. Provide new pump intake pipe, anchored to pond bottom, and trenched or pulled through ground to Pump Station.
 - c. Provide New Pump Station located adjacent to Existing Aerator Control System. Coordinate and provide all electrical connections for Pump Station at this location.
 - d. Pump Station shall be set to operate on timed controls as requested by Owner.
 - e. Provide new Pump Station outlet at Tempietto basin for one (1) small water form that may include, but not limited to, the following:
 - 1) Foamer
 - 2) Bubbler
 - 3) Umbrella
 - f. Coordinate and integrate mechanical system with Base Bid Drain and Valve System.
 - g. Provide all temporary erosion control and cofferdam equipment required to install pump system wet well and intake pipe meeting requirements by law (local Conservation Commission, etc.).
 - 3. Add Alternate Bid #3
 - a. Provide Newly Drilled Bedrock Well and Pump System in lieu of Pond Pumping System to provide water source for Water Feature System.
 - b. Provide Control Panel Enclosure, Pressure Relief, and Filtration to same extent as Pond Pumping System
- E. Work items specifically included:

1. Procurement of all applicable licenses, permits, and fees.
2. Coordination of all utilities required for water feature mechanical system.
3. Verification of existing and proposed site conditions, notifying Owner's Representative immediately of any discrepancies or discoveries yet to be determined.
4. Installation of all water feature hydraulic and control systems.
5. Maintenance and repairs during guarantee period, including first-year spring startup and winterization.
6. Training with Owner as well as Operation and Maintenance Manual.
7. Provide an optional long-term service contract (winterization, spring startup, remote monitoring) for Owner's consideration.

F. Related Sections include the following:

1. Section 024100 Selective Demolition
2. Section 024113 Site Preparation and Demolition
3. Section 033300 Architectural Concrete
4. Section 03400 Precast Concrete
5. Section 044300 Stone Masonry
6. Section 310000 Earthwork
7. Section 312500 Erosion and Sedimentation Controls
8. Section 321216 Bituminous Concrete Paving
9. Section 321313 Concrete Paving
10. Section 323300 Site Furnishings
11. Section 328424 Bedrock Well Installation (Add Alternate #3)
12. Section 329219 Seeding

1.3 UTILITIES

- A. Provide licensed electrician through electrical contractor meeting requirements of Division 1.
- B. Provide thorough observation and inspection of existing electrical supply as shown on the Drawings. Spare 20-amp circuit is available for defunct pump system, as part of Pond Fountain distribution panel.
- C. Existing electrical meter is for 240-Volt service. Existing GFCI receptacles exist within Pond Fountain aerator and compressor.
- D. As part of Add Alternate #2 and #3 Bid, provide additional price for pump station to be equipped with optional cellular modem for web-based communication and commissioning by Owner for Tempietto Water Feature.
- E. Provide separate line item for upgraded electrical service at existing distribution panel enclosure if existing service is inadequate (Add Alternate #2 and #3).

1.4 CONDITIONS

- A. Review all relevant Construction Documents before submitting bid including referenced Drawings and Specifications, as well as overall Contract Construction Documents.
- B. Review existing conditions on site before submitting bid such as:
 1. Topography, Bathymetry, and Grade Changes

2. Structures
 3. Utilities (Existing and Proposed)
 4. Unauthorized requests for extra time or compensation due to actual conditions being inconsistent with those assumed shall not be honored.
- C. Provide all trenching, bedding material, backfilling, and compaction for all in-ground water feature system components.
 - D. Provide all testing and final adjustment of completed water feature system including visual and aural effects, as well as, pumping and filter settings for optimum and safe performance.
 - E. Provide Record Drawing with standards outlined in Specifications.
 - F. Provide Training to Owner for overall system Operations & Maintenance.
 - G. Provide Operations & Maintenance Manual with standards outlined in Specifications.
 - H. Drawings and Specifications shall comprise single Construction Document intended to convey design intent. Provide and install all products and materials to meet design intent conveyed by Construction Documents whether specifically outlined or not. Apparent discrepancies or questions of intent shall be directed in writing to Owner's Representative for final, conclusive and binding decision.
 - I. Installation work shall be performed efficiently, timely, and completely to full design intent of Construction Documents.
 - J. Guarantee
 1. Guarantee entire water feature 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.
 2. System malfunctions occurring during 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 Owner.
 3. First-year spring start-up and winterization shall be included in system guarantee.
 - K. 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. These warranties shall be in addition to other binding warranties or guarantees.
- 1.5 SUBMITTALS
- A. Provide electronic copies of product sheets, catalog cuts, and shop drawings for all product specified to Owner's Representative for approval as per Division 1.
 - 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 (for same bid price) and performance are submitted and approved (by Owner's Representative) in the procedure outlined below.
 - 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
 - 5. Work shall not commence until all products specified are submitted and approved in written notification by Owner's Representative.
- E. All product installed shall be new, without defects, and of quality and performance as specified and meeting requirements of system.
- F. Schedule
 - 1. Schedule pre-construction meeting with Owner's Representative(s) to discuss project, design intent, project coordination, trade coordination, tree protection and root preservation measures, submittals required, and construction schedule.
 - 2. Submit Schedule of all products to be furnished hereunder, indicating manufacturer, size, and model.
 - 3. Ensure that all of the types/styles of products and installation equipment specified herein can be furnished by the manufacturer submitted.
 - 4. Prior to submitting schedule, confirm current site conditions are as shown in Construction Drawings.
 - 5. At key points during system when exposed, contact Owner's Representative to arrange for progress site visit for installation observation.
 - 6. At completion of installation, contact Owner's Representative to arrange for punchlist site visit to observe installation, operation, water form appearance, and system performance.
 - 7. One-year guarantee of system shall not commence until all punchlist items have been addressed.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver materials to site, until all specified submittals have been submitted to, Owner's Representative for approval.
- B. Coordinate with Owner's Representative for temporary storage and staging areas.

- C. Protect materials from damage from construction traffic, weather, corrosion, other trades, and other causes while stored on-site. Store and handle all products and materials in compliance with manufacturer instructions and recommendations.
- D. Minimize on-site storage where possible. Coordinate with site supervisor for storage options.
- E. All material overages at installation completion shall be removed from site.

1.7 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. Comply with applicable laws, standards, and regulations of the local governing authority. All local laws more stringent than those referenced above shall take precedent.

1.8 QUALIFICATIONS

- A. Qualified water feature system installers must have minimum experience of four (4) years with work and products specified herein, including:
 - 1. Commercial Water Features and/or Swimming Pools
 - 2. Large Ponds (Floating Aerator Fountains, Floating Pump Intakes)
 - 3. Filter and/or Ultraviolet (UV) Systems
 - 4. Flow-Based Sensing Systems
 - 5. Formal Water Features and Forms
 - 5. Pre-fabricated Pump Stations

PART 2 - PRODUCTS

2.1 BASIN FLOOR DRAIN (BASE BID)

- A. Size: 2-Inch NPT Outlet, 6-Inch Diameter at Floor
- B. Construction: Bronze Body, Stainless Steel Hardware
- C. Ratings: NSF Rating, Waterproof Liner Clamp at Collar
- D. Features: Bronze Round Strainer Grate with 3/8-inch maximum openings, Reversible Collar to raise and lower strainer positions, Replace or Add Flat Plate Cover for normal operation (use Strainer Grate for winter operation).

E. Manufacturers and Models (or Approved Equals):

1. Jay R. Smith, Model 2009 Floor Drain

2.2 SIDEWALL OVERFLOW DRAIN (BASE BID)

A. Size: 1½-Inch Copper NPT Outlet, 3¾-Inch Square Grate Opening at Sidewall

B. Construction: Bronze Body, Stainless Steel Hardware

C. Features: Neoprene Rubber Seal Ring

D. Manufacturers and Models (or Approved Equals):

1. Crystal Fountains, model DOL150

2.3 WATER FORMS

A. Quantity: 1

B. Size: Spread = 3' Diameter Maximum, Height = 3' Maximum, 2-Inch Diameter Inlet

C. Construction: Bronze Body, Stainless Steel Hardware, Removable Face Plate

D. Features: Simple, Maximum Flow Requirement Approximately gpm

E. Manufacturers and Models (or Approved Equals):

1. Crystal Fountains, model WMO-101 Foam Jet (2-Inch Water Level)
2. Crystal Fountains, model NLG-201 Ground Jet
3. Crystal Fountains, model NMC-225 or 235 Tulip Jet

2.4 PIPE

A. Fountain Basin Drain Pipe (Base Bid)

1. Size: 2-Inch Maximum
2. Construction: PVC
3. Ratings: Schedule 80
4. Standards: NSF, ASTM D2241
5. Markings: Manufacturer, Nominal Size, Class or Schedule, Pressure, Extrusion Date, Pipe Insertion Mark
6. Fittings: Schedule 80 Solvent-Weld
7. Manufacturers and Models (or Approved Equals)
 - a. Cresline
 - b. Certainteed
 - c. JM Eagle

B. Fountain Basin Supply Pipe (Add Alternate #2)

1. Size: 2-Inch Maximum
2. Construction: Brass
3. Ratings: Schedule 40
4. Fittings: Schedule 40 NPT

C. Pump Supply Pipe (Add Alternate #2)

1. Size: 3-Inch Maximum
2. Construction: Molded HDPE 3608 IPS
3. Ratings: DR13.5 (128 psi)
4. Standards: ASTM D3350
5. Connection Methods:
 - a. Butt Fusion
 - b. Flanged and Mechanical Joint Adapters (at Pump Station Tee)
6. Manufacturer and Models (or Approved Equals):
 - a. ISCO
 - b. Harrington Corporation (HARCO)
 - c. EJ Prescott
7. Provide 2-inch HDPE to Metal Threaded Fused Transition Fitting from Pipe Manufacturer

D. Pond Intake Pipe (Add Alternate #2)

1. Size: 8-Inch Maximum
2. Construction: PVC
3. Ratings: Schedule 40
4. Standards: ASTM D2241
5. Connection Methods: Bell End Gasket-Joint
6. Manufacturer and Models (or Approved Equals):
 - a. Cresline
 - b. Certainteed
 - c. JM Eagle

2.5 POND INTAKE STRAINER (ADD ALTERNATE #2)

- A. Size: 8-Inch PVC Outlet, 314 Square Inch Opening
- B. Construction: Aluminum
- C. Features: ¼-inch Openings in Strainer
- D. Manufacturers and Models (or Approved Equals):
 1. Sure-Flo, Model SPVCJ8

- 2.6 CONCRETE WET WELL MANHOLE (ADD ALTERNATE #2)
- A. Size: 3-foot Diameter Interior, 6-inch Thick Walls, 8-foot Deep
 - B. Construction: 5,000 psi Concrete (at 28 Days), Cast Iron Frame and Vented Cover
 - C. Features: Kor-N-Seal Waterproof Boots for Pipe Penetrations, Counter-buoyancy Weights through steel rebar or thicker bottom collar, H-20 Rated
 - D. Manufacturers and Models (or Approved Equals):
 - 1. Shea Concrete, Mini Catch Basin
- 2.7 CONCRETE DRY WELL (ADD ALTERNATE #2 – BACKFLUSH & PRESSURE RELIEF DISCHARGE)
- A. Concrete Dry Well
 - 1. Size: 4.0' x 4.5' x 4.25' Deep
 - 2. Construction: Concrete (28-Day Strength = 4,000 psi)
 - 3. Ratings: H-20 Rated Loading
 - 4. Features: 20-inch diameter top opening, covered with 24-inch cast iron cover brought to finish grade
 - a. Surround Dry Well with Crushed Stone (1-Inch Minimum)
 - b. Surround Crushed Stone with Landscape Fabric (see below)
 - 5. Manufacturer: E.F. Shea Concrete; or Approved Equal.
 - B. Filter Fabric
 - 1. Type: Woven Geotextile
 - 2. Construction: UV Stabilized Propylene Filament
 - 3. Strength:
 - a. Tensile Strength(lbs): 365MD/200CD
 - b. Puncture (lbs): 115MD/75CD
 - 4. Opening Size (AOS): 40 Sieve ASTM
 - 5. Flow Rate: 145g/m/sf
 - 6. Standards: ASTMD4632, ASTM D6241, ASTM4491, DD4751
 - 7. Markings: Manufacturer, Nominal Size, Class or Schedule, Pressure, Extrusion Date, Pipe Insertion Mark.
 - C. Manufacturer: TenCate Mirafe FW402; or Approved Equal.
- 2.6 VALVE BOXES (ADD ALTERNATE #2)
- A. General

1. Size:
 - a. 18-Inch Jumbo Valve Box
 - 1) 2-Inch HDPE to Metal Fitting with Isolation Valve
 - b. 10-Inch Round
 - 1) Grounding Rod
2. Construction: Resin
3. Ratings: Tensile Strength 3,000-5,000 psi
4. Color: Green or Black (per Owner's Representative)
5. Features: Lockable, Bolted-Down Covers, Brick Supported
6. Manufacturer/Model: Carson, Model Specification Grade NDS Pro; Rain Bird VB; or Approved Equal.

2.7 ISOLATION VALVES (ADD ALTERNATE #2)

- A. Size: 2-Inch and Smaller
- B. Construction: Bronze, Gate Valve
- C. Ratings: 200 psi
- D. Features: Steel Cross Handle, Non-Rising Stem
- E. Manufacturer/Model: Nibco T-113K; Apollo 102T-K; or Approved Equal

2.8 OUTDOOR GROUNDING (ADD ALTERNATE #2)

- A. Size:
 1. Wire: 6AWG Bare
 2. Rod: 5/8-Inch Diameter x 10-Foot Long
- B. Construction:
 1. Wire: Copper
 2. Rod: Copper
- C. Ratings: UL-Listed
- D. Features: Cadweld Connectors from Wire to Rod

2.9 PUMP SYSTEM (ADD ALTERNATE #2)

- A. Sequence of Operation

1. Water Feature Pump System shall draw water from adjacent pond through wet well and screened intake set in pond above bottom and below water surface a minimum of 2 feet for maximum quality water.
2. Water Feature Pump System shall start and stop based on hours of operation as determined by Owner.
3. Water Feature Pump shall stop based on the suggest, but not limited to, the following system faults:
 - a. High Pressure
 - b. Low Pressure
 - c. Low Water Level in Wet Well
 - d. Under or Over Current
 - e. High Temperature
 - f. Filter System Fault

B. Submersible Power Wire to Pumps

1. Size: 10AWG Minimum, Carry Full Load Amps at 240-Volt, 1-Phase without exceeding 67% Amperage Capacity of Conductor, 3-Wire with Ground Cable sized to NEC Requirements in liquid-tight container (verify final available voltage)
2. Construction: Copper Conductors with PVC Insulation.
3. Ratings: UL-Listed, NEC (Class II Circuit), Direct Burial UF/TWU, up to 600-Volt Potential
4. Features: Spliced in watertight, quick disconnects
5. Markings: Manufacturer, Rating, Size and Type
6. Manufacturers: Paige Electric, Service Wire Company, Regency Wire & Cable, or Approved Equal

C. Pressure Transducer Wire

1. Proprietary to Component Manufacturer
2. Within Conduit, Vented and Shielded
3. Manufacturer shall supply sufficient wire length for direction connection (no splices)

D. Wire Splices (where necessary, supply enough wire for straight runs to and from Panel)

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, or Approved Equal (Low Voltage); 3M, Model 82-A2 (High Voltage), or Approved Equal.

D. Wire Conduit

1. Size: 2-inch Minimum
2. Construction: Polyvinyl Chloride (PVC), Solvent Weld Below-Grade; Galvanized Steel Above-Grade

3. Ratings: Schedule 40
4. Fittings: Long Sweep Elbows
5. Manufacturers: Cresline; Certainteed; JM Eagle; or Approved Equal.

E. Check Valve

1. Size: 1.5-Inch (NPT)
2. Construction: Wafer-Style with Stainless Steel Body and Teflon Seals
3. Ratings: 200 psi
4. Features: Horizontal or Vertical Orientation, Constructed Specifically for VFD Systems
5. Manufacturers: Danfoss Flomatic, W.L. Hamilton; or Approved Equal

F. Pre-Packaged Pump Station

1. Provide following equipment:
 - a. Submersible Pump and Flow Induction Sleeve in Pump Chamber
 - b. Timed Controls for:
 - 1.) Pump in Pump Chamber
 - c. NEMA 12 Outdoor Enclosure
 - d. Additional Controls for:
 - 1.) Automatic Filtration
 - 2.) Low Water Level Cut-Out Switch
 - 3.) Ultraviolet (UV) Disinfection
 - e. Cellular Data Plan for Web Interface (Optional)
 - f. Integral Pipe and Fittings
 - g. Liquid Level Controls and/or Run-Dry Protection
 - h. Valves
 - i. Pressure and/or Flow Sensors
 - j. Programmable logic controller (PLC)
 - k. UL 508A listed control panel
 - l. All appurtenances necessary for complete and functioning pumping system.
2. Pump station shall be mounted to press brake formed steel base and enclosed in powder-coated marine grade aluminum enclosure.
3. Pump station shall be manufactured by UL QCZJ certified pump station manufacturer, such as Precision Pump Systems, Inc., or approved equal.

G. Technical Service and Support

1. Manufacturer shall provide access 24/7 phone support with factory certified technician.
2. Technician shall have access to all relevant data specific to pump station, including Specifications, submittal, shop drawings, programming, and detailed photos of system.

H. Factory Testing

1. Pump station shall undergo and pass all of following system performance tests:
 - a. Hydrostatic testing that meets ANSI/HI Specifications and standards

- b. Flow testing that meets ANSI/HI 14.6 Specifications and standards
 - c. Vibration testing that meets ANSI/HI 9.6.4 Vibration Measurement and Allowable Values Specifications and standards
 2. Pump system shall be flow tested as complete unit, which shall include function testing of pumps, motors, instrumentation, appurtenances, and control panel. Results of all tests shall be available to Owner's Representative.
- I. Submersible Pump and Motor (Add Alternate #2 in Pump Chamber)
 1. Duty Point: 100 feet TDH (43 psi) at 40 gpm at surface
 2. Power: 1.5-horsepower submersible motor at 240-Volt, 1-Phase
 3. Inlet: Stainless Steel Floating Filter with 15' Hose; Manufacturer-Provided Flow Induction Sleeve with Floor Supports at 15 degrees
 4. Discharge: 1.5-inch NPT with Flexible Hose and Dixon Cam and Groove Coupling Connection (Locking)
 5. Manufacturers: RainHarvest Systems, Model FI (Pump, Sleeve, and Filter Inlet Only—Controls shall be per Specification), or Approved Equal.
- J. Pipe, Valves, Skid Base, & Station Enclosure
 1. Pipe
 - a. Pump Station pipe shall be standard wall pipe with grooved connections.
 - b. Flanged or welded connections shall not be acceptable.
 - c. Threaded connections between main pipe sections other than at pump volute shall not be acceptable.
 2. Valves
 - a. Butterfly style isolation valves with grooved connections shall be included on station suction and discharge piping.
 - b. Flanged or threaded connections shall not be accepted.
 - c. Non-slam check valve shall be included on discharge of each pump.
 - d. Air release valve shall be included, located immediately after pump check valve.
 - e. Pressure relief valves shall be provided with discharge to adjacent stormwater drainage system.
 3. Skid
 - a. Pump Station skid shall be made of 1/4" press broke A36 steel.
 - b. No welded bases or open rail systems shall be acceptable.
 4. Corrosion Protection
 - a. Pump skid and appurtenances shall be cleaned to bare steel and coated with baked-on powder coating, all piping including elbows shall be coated inside and out.
 - b. Pump station shall be pressure tested prior to coating. No welding shall be performed after pump station is powder coated.
 5. Station Enclosure
 - a. Pump station enclosure shall be constructed of marine grade aluminum modular panels to allow access to all pumps and components by simply removing any panel.

- b. Entire front of enclosure shall consist of hinged doors.
 - c. Enclosure shall be powder coated.
 - d. Roof of enclosure shall be easily displaced and replaced by one person for purpose of servicing pump station.
 - e. Pump Station enclosure shall include ventilation fan (or fans) appropriately sized to adequately cool enclosed equipment.
6. Automatic Filter
- a. Pump Station shall include an automatic screen filter.
 - b. Filter shall use suction scanning devices to automatically remove debris from filter element by scheduled time interval to not interfere with overnight watering window.
 - c. Filter shall be VAF200 or approved equal.
 - d. Control logic for filter flush shall be included as part of main control panel PLC programming.
7. Ultraviolet Disinfection
- a. Provide UV lamps with adequate wattage and flow for pump duty point (40 gpm).
 - b. UV system shall be on-demand with pump system.
 - c. UV system shall be compatible with filtration system upstream for maximum efficiency.
 - d. UV system shall have wiper to clean quartz sleeve periodically.
 - e. UV system shall be Viqua or approved equal.
- K. Pump Control System
1. NEMA Rating
- a. VFD, PLC, and associated electrical equipment shall be mounted in NEMA 12 enclosure rated for indoor installation.
 - b. To avoid potential water or rodent damage, VFDs mounted outside main control panel are not acceptable.
2. Control Panel Manufacturing & Testing
- a. Pump control panel shall be manufactured and listed by UL508A Panel Shop.
 - b. Panel shall be UL labeled as an "Enclosed Industrial Control Panel".
 - c. Pump control panel shall be completely manufactured, tested and programmed prior to delivery to site.
3. Documentation
- a. Color wiring schematic and pump nameplate information shall be permanently affixed to inside of control enclosure.
 - b. All field terminal connections shall be numbered and labeled.
4. Cooling System
- a. Control panel cooling system shall be appropriately sized for ambient conditions.
 - b. Cooling system shall not allow dust, insects or rodents inside pump control panel.
 - c. Two sets of spare filters shall be included with pumping system.
5. Main Disconnect

- a. Service-entrance rated, non-fused disconnect shall be mounted in pump control panel and shall isolate all power to control panel.
 - b. Disconnect shall include an operating handle mounted on control panel enclosure door that is mechanically interlocked to prevent entry while disconnect is in ON position.
 - c. To prevent damage from vandalism, disconnect external to pump station enclosure shall not be accepted.
6. Overcurrent Protection
- a. VFD bridge rectifiers shall be protected from over current by an appropriately sized circuit breaker.
 - b. Fuses are not acceptable.
7. Lightning & Surge Protection
- a. Pump Control Panel shall be equipped with transient voltage and surge arrestors.
8. Variable Frequency Drive (VFD)
- a. VFD shall be appropriately sized to meet FLA (full load amps) required by pump motor, as stated on motor nameplate.
 - b. VFD shall be manufactured by ABB Industrial Systems, Mitsubishi, or approved equal.
 - c. Initial start-up and calibration shall be performed by factory certified technician, which shall extend warranty on control panel to total of three (3) years.
9. Programmable Logic Controller (PLC)
- a. PLC shall be fully programmed prior to pump panel installation.
 - b. Technician installing and programming PLC is to be factory trained and certified by PLC manufacturer.
 - c. PLC programming shall be non-proprietary, and complete station programming shall be made available to Owner's Representative via USB drive included with station control panel.
10. PLC Operator Interface
- a. PLC shall be equipped with 5.7-inch LCD color touchscreen.
 - b. Operator interface shall allow user to make adjustments to PLC program locally without requiring any additional equipment such as laptop computers.
 - c. VFD control keypad is not acceptable substitution for digital operator interface.
 - d. PLC shall have Ethernet port to enable remote access.
11. PLC Control Functions
- a. User settable Local or Remote control.
 - b. System Pressure Setpoint
 - c. Pump Sleep Settings, with two threshold modes: Sleep by Flow or Sleep by Frequency
 - d. System Protection Settings, including fault and warning parameters for low flow, high flow, low pressure, high pressure, restart trials and restart delay time.
 - e. Load Factory Default Settings, User Saved Default Settings.
 - f. Pre-Programmed Start-Up Routines to limit and/or delay starting and acceleration of pump to eliminate excessive velocity and pressure.
 - g. It shall also include initial start-up, mainline fill, power outage and automatic re-starts.

12. PLC Monitoring Functions
 - a. Pump operating status, total pump run hours, motor frequency, motor amperage
 - b. System pressure, flow rate
 - c. Fault Log with time stamps and diagnostic utility.
 - d. Trend Data, with graphic display of system pressure, flow, motor frequency and amperage. Data shall be exportable to MS Excel.
 - e. USB port to upload, download of program, and data storage.
13. Instrumentation
 - a. Pressure Gauges shall have 304SS stainless steel case, with bezel construction. Gauges shall have 2.5-inch diameter and be liquid filled.
 - b. Pressure Transmitter(s) shall be constructed of stainless steel and rated for pump station discharge pressure.
14. Flow Meter
 - a. Pump station shall include solid-state insertion flow meter. Paddle type insertion sensors shall not be accepted.
15. Vacuum Primer Pump
 - a. Pump station shall include an automatic vacuum primer pump system.
 - b. System shall automatically maintain prime for pump.
16. Insertion Flow Meter
 - a. Pump station shall include programmable NMP insertion flow meter with an accuracy of 7% MW + 2% MEW.
 - b. Flow meter shall include digital display on meter body as well as 4-20 mA outputs for remote display and operations.
 - c. All wetted parts shall be 316 stainless steel.
 - d. Paddle and propeller meters are not acceptable.

PART 3 - EXECUTION

3.1 GENERAL

- A. Competent superintendents and assistants shall be on-site at all times during product delivery, installation, testing, and system adjustments.
 1. Field communication by Owner or Owner's Representative to superintendent shall be binding.
- B. System features shall be laid out as indicated on Drawings, making minor adjustments for variations in planting arrangements or field conditions. Major changes shall be reviewed with Owner's Representative before acceptance.
 1. Water feature lines and conduits shown on Construction Drawings are diagrammatic only. Location of equipment is contingent upon and subject to integration with all other underground utilities, tree roots, and hardscape design elements.

3.2 EXAMINATION

- A. Review and verify project conditions are as indicated on Construction Drawings prior to starting work, including but not limited to:
 - 1. Utilities provided by Others
 - 2. Site grades and dimensions
 - 3. Landscaping, trees to remain, and features
 - 4. Structures
 - 5. Pipe sleeves
- B. Report any irregularities of site conditions to the Owner's Representative prior to beginning work.
- C. Beginning of installation connotes acceptance of existing project conditions.

3.3 PROJECT COORDINATION

- A. Coordinate with Owner's Representative to expeditiously install system.
- B. Provide written notifications (electronic is acceptable) to Owner's Representative prior to work commencement, weekly for progress report, for any proposed changes to system design, and upon installation completion.
- C. 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).
- D. Utility Coordination
 - 1. Maintain 6-inch minimum clearance between water feature lines and any utility line. Do not install water feature conduit or pipe directly above another utility of any kind.
 - 2. Exercise care when excavating, trenching and working near existing utilities.

3.4 SITE PROTECTION

- A. Protect landscaping, protected and unprotected trees to remain, paving, structures, walls, footings, etc. from damage caused during work. Damage to work of another trade shall be reported at once.
- B. Replace or repair any damage with same product or material, to the satisfaction of Owner's Representative at no additional cost to the Owner per Guarantee.
 - 1. See 024113 Site Preparation and Demolition Sections 1.8 and 3.2.

3.5 GENERAL ELECTRICAL NOTES

- A. Installation Notes and Procedures
 - 1. Employ or subcontract licensed electricians in site jurisdiction to perform all work.
 - 2. Take all personal and construction precautions for installation of electrical equipment and conductors in water.

3. Verify all existing and proposed site conditions prior to bidding and installation of water feature equipment. Immediately notify Owner's Representative of conflicts between Construction Documents and actual site conditions.
4. All work shall conform to NEC, state, and local electrical codes, whichever is most stringent.
5. All work shall conform to NEC Article 680 "Swimming Pools, Fountains, and Similar Installations".
6. Install Class A Ground Fault Circuit Interrupters (GFCI) on each branch circuit supplying underwater fountain equipment.
7. Provide all GFCI protected circuits with separate neutrals.
8. Provide all GFCI breakers with pigtails wired to neutral bar.
9. Protect all equipment reliant on submersion from overheating through:
 - a. independent low water cutoff sensing and devices, and/or
 - b. internal thermal bimetallic ambient compensating overload.
10. Maximum exposed submersible wire length is 20 feet. Prepare splices in watertight junction boxes only. Conductors and wires outside of water feature shall be in conduit as scheduled by NEC.
11. Provide minimum 3 feet of slack in conductors and wires for service of all electrical equipment.
12. Secure all fixtures and electrical equipment to walls and floors of water feature with non-corrosive fasteners for underwater applications.
13. Install UL-listed, rigid, ultraviolet light resistant, PVC Schedule 80 conduit between junction boxes, and control panels rated for above and below-grade use. Provide solvent-weld connections for all fittings with specified primer and cement. Protect all conduit from water and soil entry before, during, and after construction.
14. Install underwater electrical wire and conductors rated for continuous submerged use.
15. Upsize all wire by one (1) AWG size for all lengths exceeding 200 feet and an additional AWG size for each additional 100 feet.
16. Supply threaded conduit entries and compression connectors for wire entry for all underwater junction boxes.
17. Provide conduit for individual runs of wire as required by NEC and do not combine wires for different fixtures and purposes in same conduit.
18. Provide corrosion-resistant conduit as required for electrical wire, conductors, grounding, and bonding.
19. Coordinate with site contractor for penetrations and waterproofing of conduit through all structures. Provide flexible conduit connections where settlement of structures is expected.
20. Install no more than four (4) 90-degree elbows in single conduit run. Use long-sweep elbows at all required bends.
21. Install shielded control wire for liquid level and other sensors to prevent interference from low voltage conductors.
22. Bond and ground all electrical equipment as per NEC requirements. Provide all bonding lugs. Ensure that all metal water feature equipment, including lights, drains, pump discharge outlets, conduits, pipe, and drains.
23. Install dielectric thread compound for connections between dissimilar metals to prevent galvanic degradation.
24. Ensure through testing and recording of data all electrical equipment grounding have identical reference potential. Provide data and statement of reference potential to Owner's Representative for review and approval.
25. Provide all disconnects at pump system and outdoor electrical equipment (distance and/or line-of-sight).
26. Install wire sizes that provide a minimum voltage drop of 2% between panels and electrical equipment.
27. Test all supply power to ensure incoming power is within 5% of design voltage. Coordinate with site electrical contractors to provide correct voltage with design tolerances.

28. Store and protect all equipment from weather and construction debris. Coordinate with general contractor and site supervisors for safe storage of all equipment. Clean and dust all equipment prior to installation and activation.
29. Protect and ensure all control and power supply panels are shielded from direct or indirect water contact (spray, rain, etc.).

3.6 GENERAL PIPE INSTALLATION NOTES

A. PVC Pipe Installation:

1. Cut plastic pipe with handsaw or pipe cutter, removing all burrs at cut ends. All pipe cuts shall be square and true.
2. Make all solvent-weld joints as per manufacturer's instructions and avoid applying excess primer or solvent. Do not wipe off excess solvent from each connection.
 - a. Allow welded joints minimum 15 minutes set-up/curing time before moving or handling.
 - 1) Above 80°F: Allow connections to set 24 hours.
 - 2) Below 80°F: Follow manufacturer instructions.
 - 3) Below 40°F: Prohibited.
3. Maximum deflection per joint shall not exceed manufacturer limits.
4. Maintain 1-inch minimum between lines which cross at angles of 45 to 90 degrees

B. HDPE Pipe Preparation

1. Rip soil surface with vibratory plow to depth without pipe or wire as preliminary preparation of pipe/wire pulling.
2. Pull HDPE through prepared incision.
3. Place and compact all soil/spoils back in vibratory plow incision. Compact with appropriate construction equipment (no truck tires).
4. Sections of high-density polyethylene pipe should be joined using butt-fusion into continuous lengths on-site, above ground, before installation.
 - a. Butt Fusion:
 - 1) The joining method of continuous HDPE pipe shall be by butt fusion and shall be performed in strict accordance with the pipe manufacturer's recommendations.
 - 2) The butt fusion joining will produce a joint with a weld strength equal to or greater than the tensile strength of the pipe itself.
 - 3) Butt fusion equipment must be capable of meeting all requirements by the manufacturer; including, but not limited to:
 - a) Interfacial Fusion Pressure: 75 psi
 - b) Temperature requirements: 400-450 degrees Fahrenheit
 - b. Sidewall Fusion
 - 1) Sidewall fusions for connections to outlet piping shall be performed in accordance with the pipe manufacturer's recommendations.
 - 2) The heating irons used for sidewall fusion shall have an inside diameter equal to the outside diameter of the HDPE pipe being fused. The size of the heating iron shall be ¼ inch larger than the size of the outlet branch being used.
 - c. Mechanical Joints
 - 1) Use mechanical joints where butt fusion cannot be used.
 - 2) Mechanical Joints will use either
 - a) HDPE flange adapter with ductile iron back-up ring, or
 - b) HDPE Mechanical Joint adapter with ductile iron back-up ring

- d. Socket fusion, hot gas fusion, threading, solvents, and/or epoxies are not acceptable methods to join HDPE pipe or fittings

3.7 TESTING AND ADJUSTMENTS

- A. Include all testing and adjustments in submitted bid price.
- B. System Flushing:
 1. Open valves and flush out water feature system under full head of water before installing nozzles, drains, and outlets.
 2. Flush entire system after complete installation.
 3. Clogged nozzles and drains shall be remedied after completion of water feature system.
- C. Testing:
 1. Test all pipe and valves for leaks at operating pressure. Repair all leaks and retest until leaks are remedied.
 2. Perform water feature effects test with Owner's Representative present. Readjust settings as necessary to attain proper effects. Replace any equipment that does not meet specified standards.
 3. After testing, clean all equipment of debris during installation.
- D. Throughout guarantee period, adjust water feature effects due to settlement and climate variation.

3.8 RECORD DOCUMENTS

- A. Record (As-Built) Drawings
 1. Maintain and update Record Drawings with red-line markings as project progresses, including locations of:
 - a. Fountains, water features, elements and descriptions)
 - b. Valve descriptions
 - c. All equipment installed with distinct symbols
 - d. Pipe routing and tees
 - e. Wire routing, splicing, and fixture locations
 4. Locations of installed equipment (valve, controller, sensors) shall be referenced by two permanent locations (swing ties) or GPS.
 5. Make all notes legible as work progresses, any new equipment added shall use distinct symbols denoting location.
 6. Document any changes from original Construction Drawings.
 7. Prints of original Construction Drawings may be obtained from the Owner's Representative at cost (0% markup).
 8. 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.
- B. Record Documents
 1. Record Documents shall be on-site at all times. Maintain record of the following as the project progresses:
 - a. Plumbing and Electrical permits (state whether or not required)
 - b. Materials Approved and approval date

- c. Materials delivered, Accepted, and Installed by whom and date.
 - d. Field Communications and Requests for Information (RFI)
- C. Prior to final punchlist, provide complete electronic and hard copy files of Record Drawings and Documents to Owner's Representative as part of project completion. All information must be complete and shall be added to submitted documents prior to acceptance.

3.9 OPERATION AND MAINTENANCE

A. General

- 1. Bid price shall include up to four (4) hours of water feature system overview and instruction with Owner and/or Owner's Representative.

B. Operation and Maintenance Manual

- 1. Provide three (3) hard cover binders titled "Operation and Maintenance for LARZ ANDERSON WATER FEATURE" prior to application for acceptance and final payment.
- 9. Operation and Maintenance Manual shall include, but not be limited to:
 - a. Title Page and Table of Contents
 - b. One-Paragraph Written Description of Water Feature System
 - c. Manufacturers' Data and Cut Sheets of Equipment, including:
 - 1) Copies of all approved submittals
 - 2) Wire resistance readings to each electric valve at completion (for future troubleshooting)
 - 3) Recommended operating settings
 - 4) Recommended maintenance schedule
 - 5) Name, address, and telephone number of installer (for repairs, spring startup, and winterization during 1-year guarantee period)
 - 6) Water Feature program for periods without wind, rain, and recommended settings including, run time, days per week, and rain-wind sensor suspension.
 - d. Pump Control System Settings
 - e. Lighting Control System Settings
 - f. Winterization and Spring Startup Instructions (after 1-year guarantee period)
 - g. Guarantee Data
 - h. Pockets with Folded Plans of:
 - 1) Original Design Drawing
 - 2) Final Record Drawing
 - 3) Valve and Wiring System Diagram Drawing

3.10 SITE CLEANUP

- A. Remove all unused materials and equipment from project site safely and efficiently. Dispose of all unused materials legally - including construction debris and trash.

3.11 FINAL OWNER ACCEPTANCE

- A. Final Owner Acceptance of Water Feature 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. Proper Programming of Water Feature and Chemistry Controls.
 - 4. Completed and approved all punchlist items.

- 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 period as described above.

END OF SECTION

SECTION 310000

EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and relevant sections of these Specifications, apply to the work specified in this Section.

1.2 RELATED SECTIONS

- A. Related Sections include, but are not limited, to the following:
 - 1. Section 024100 Selective Demolition
 - 2. Section 024113 Site Preparation & Demolition
 - 3. Section 024119 Temporary Shoring, Bracing, and Protection
 - 4. Section 312500 Erosion and Sedimentation Controls

1.3 SCOPE OF WORK

- A. The work of this section includes but is not necessarily limited to the following:
 - 1. Excavating, filling, grading, and backfilling.
 - 2. Providing, placing, and compacting of backfill materials.

1.4 SUBMITTALS

- A. Soil Materials: Submit 75-lb samples and results of recent (within previous month) grain size analyses for each soil material at least three weeks prior to use and no more than 6 months prior to use.
- B. Synthetic Materials: Submit manufacturer's information for synthetic materials at least three weeks prior to use.
- C. Soil Disposal: Submit proposed disposal facilities, and receipts for disposed soils as required in paragraph 3.12.
- D. Excavation Support: Submit designs for cut slopes, trench boxes, and excavation support systems. For cut slopes, submit sketches showing maximum excavation depth and proposed slopes. For trench boxes, submit manufacturer's data and sketches showing trench geometry. For excavation support systems, submit plans and calculations prepared and stamped by an engineer registered in Massachusetts.
- E. Provide submittals to the Owner's Representative at least 30 days before installation of the excavation support system. Submittals are for the record and do not relieve the Contractor of his sole responsibility for means and methods of construction.

1.5 EXISTING CONDITIONS

- A. Site Information:
 - 1. Existing conditions and topographic data are from a survey prepared by DGT Associates Surveying & Engineering, 1071 Worcester Road, Framingham, MA 01701, (508) 879-0030.
 - 2. The Contractor may perform test borings and other explorations at no cost to Owner.
- B. Existing Utilities:
 - 1. Locate existing underground utilities in areas of work. Provide adequate means of support and protection during earthwork operations.
 - 2. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
 - 3. Do not interrupt existing utilities serving facilities occupied and used by Owner or others during occupied hours, except when permitted in writing by Owner and then only after acceptable temporary utility services have been provided.
 - a. Provide minimum of 48-hour notice to Owner, and receive written notice to proceed before interrupting any utility.
- C. Protection of Existing Structures: Provide bracing, shoring, sheeting, underpinning or other retaining structures necessary to prevent movement or settlement of existing or new construction, utilities, paving, light standards, piping or conduit. Responsibility for the strength and adequacy of retaining structures, and for the safety and support of construction, utilities, or paving, and for any movement, settlement, or damage thereto shall be the Contractor's responsibility. In exercising this responsibility, the Contractor shall, if required, retain a qualified consultant who is a licensed Professional Engineer registered in the Commonwealth of Massachusetts to design, check, and approve all temporary retaining structures and other items pertinent to this work.
- D. Protection of Existing Trees to Remain. Refer to Section 024113 Site Preparation and Demolition.

1.6 LAYOUT AND GRADES

- A. Layout work, establish and maintain necessary markers, bench marks, grading stakes, and other stakes as required. Establish permanent benchmarks by employment of a registered land surveyor or professional civil engineer. Bring any deviations from the locations and elevations indicated on the Drawings to the attention of the Owner's Representative immediately.
- B. Verify all existing ground surface elevations within the contract limits.
- C. The Owner's Representative may make such adjustments in the field in grades and alignments as are found necessary in order to avoid interference with any special conditions encountered.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Ordinary Borrow: Granular soil, free from debris, organics, or frozen materials. Ordinary Borrow shall have less than 20% by weight passing the No. 200 sieve and shall contain no stones larger than 6 inches in maximum dimension. On-Site Fill may be used with the approval of the Owner's Representative and does not necessarily need to meet the above requirements for ordinary borrow.
- B. Crushed Stone: Conform to the requirements of Massachusetts Highway Department (MHD) Standard Specifications for Highways and Bridges, Section M2.01.4 or M2.01.5 (3/4 inch or 1/2 inch stone).
- C. Dense Graded Crushed Stone: Conform to the requirements of Massachusetts Highway Department (MHD) Standard Specifications for Highways and Bridges, Section M2.01.7 (1-1/2 inch stone).
- D. Clean Washed Crushed Stone: Conform to the requirements of Massachusetts Highway Department (MHD) Standard Specifications for Highways and Bridges, Section M2.01.1, M2.01.2, M2.01.3, or M2.01.4 (3/4 inch to 1-1/2 inch stone) and shall be clean and washed.
- E. Peastone: Conform to the Massachusetts Highway Department (MHD) Standard Specifications for Highways and Bridges, Section M2.01.6.
- F. Stone Pipe Ends: Conform to the Massachusetts Highway Department (MHD) Standard Specifications for Highways and Bridges, Section M2.02.4 Modified Rockfill.
- G. Structural Fill: Well-graded natural sand and gravel free from deleterious materials conforming to following gradation:

<u>Opening or Sieve No.</u>	<u>Percent Passing by Weight</u>
3 inches	100
1/2 inch	50-100
No. 4	35-85
No. 16	20-65
No. 50	5-40
No. 200	0-8

- H. Select Fill: Same requirements as Structural Fill except the percent passing the No. 200 sieve shall be 0-4 percent.
- I. On-Site Fill: On-Site Fill may be used in lieu of Ordinary Borrow with the approval of the Owner's Representative. Screen and remove all asphalt, cobbles, and boulders larger than 6 inches from the On-Site Fill.
- J. Pavement Subbase: See Pavement Specification Sections.
- K. Sand Bedding: MHD Section M1.04.0 Type B.
- L. Loam: A "fine sandy loam" or a "sandy loam" determined by mechanical analysis (ASTM D-422) and based on the "USDA Classification System". It shall be of uniform composition, without admixture of subsoil. It shall be free of stones greater than one inch (1"), lumps,

plants and their roots, debris and other extraneous matter as determined by the Owner's Representative.

1. Loam shall have the following mechanical properties:

<u>Textural Class</u>	<u>% of Total Weight</u>	<u>Average %</u>
Sand (0.05 - 2.0 mm dia. range)	45 - 75	60
Silt (0.002-0.05 mm dia. range)	15 - 35	25
Clay (less than 0.002 mm dia. range)	5 - 20	15

2. Loam shall have an acidity range of pH 6.0 to pH 6.5 and shall contain not less than 4% nor more than 8% organic matter, as certified by required tests.
3. All loam proposed for use shall be tested for conformance to the specifications.

2.2 USE OF SOIL MATERIALS

- A. Use Crushed Stone, Dense Graded Crushed Stone, or Select Fill (at the Contractor's option) below all exterior slabs-on-grade, and as indicated on the Drawings.
- B. Use Structural Fill as backfill in the following locations:
 1. As shown on the drawings.
 2. Below footings, where fill is required.
- C. Use Ordinary Borrow if additional fill is required and other fill materials are not specified otherwise. Use On-Site Fill at locations approved by the Owner's Representative.
- D. Use Loam where existing lawn areas disturbed by construction must be restored.

2.3 SYNTHETIC MATERIALS

- A. Stabilization Non-woven Geotextile: Non-woven, needle-punched, meeting the requirements of AASHTO M 288 for Stabilization Geotextile.
- B. Stabilization Woven Geotextile: Woven, meeting the requirements of AASHTO M 288 Class 1 for Stabilization Geotextile. Use stabilization geotextile as shown on the drawings at each inlet row of the subsurface detention system to prevent scouring of the foundation stone
- C. Separation Non-woven Geotextile: Non-woven, needle-punched, meeting the requirements of AASHTO M 288 Class 2 for Separation Geotextile. Use separation geotextile as shown on the drawings for athletic field subdrains, french drain, wet meadow bioretention, stone pipe ends, vegetated swale, subsurface detention system, and subsurface level spreader.
- D. Thermoplastic Liner: Non-reinforced 30-mil polyvinyl chloride (PVC) meeting the requirements of ASTM D-7176. Use thermoplastic liner as shown on the drawings for the subsurface detention system.

PART 3 - EXECUTION

3.1 GENERAL

- A. Protect existing trees, plantings, structures, utilities, sidewalks, pavements, and other facilities from damage by equipment, settlement, undermining, washout, and other hazards created by earthwork operations.
- B. Perform excavation work in compliance with OSHA guidelines and regulations.
- C. Keep excavation continuously free of water from all sources without extra cost to the Owner. Should surface, rain or ground water 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 from such water. All piping exposed above surface for this use shall be properly covered to allow foot traffic and vehicles to pass without obstruction.

3.2 EXCAVATION

- A. Excavation includes removal and placement (cut and fill) of materials to subgrade elevations indicated, or required to accommodate new construction, regardless of character and obstructions encountered and shall be understood to include rock, earth, fill, foundations, pavements, curbs, piping and debris.
- B. Unauthorized Excavation: When suitable bearing material is encountered at subgrade elevations shown and excavation is made to greater depth, backfill the overexcavation with 3,000 psi concrete, at no additional cost. Select Fill may be used if approved by the Owner's Representative.
- C. Additional Excavation: When excavations for footings have reached required subgrade elevations, notify Owner's Representative who will observe the conditions.
 - 1. If suitable bearing materials are not encountered at the subgrade elevations indicated, carry excavations deeper and replace excavated material as directed by Owner's Representative.
 - 2. Removal of unsuitable material below subgrades indicated on the drawings, and its replacement as directed, will be paid in accordance with contract provisions for changes in work.
- D. Material Storage: Segregate and stockpile excavated materials until required for reuse, backfill, or off-site disposal in accordance with paragraph 3.12.
- E. Excavation for Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 feet and extending a sufficient distance from foundations to permit placing and removal of concrete formwork, installation of services, other construction, and inspection.
- F. Subgrade Preparation in Granular Soil: For footings, slabs, and other foundation structures, remove loose or disturbed soil and compact subgrade with a minimum of five passes with a vibrating roller or plate weighing at least 250 pounds and imparting an impact load of at least 2.5 tons.
- G. Subgrade Preparation in Clayey Soil: For footings, slabs, and other foundation structures, make final excavation using a smooth-bladed bucket to avoid disturbing the excavation subgrade. Immediately cover the subgrade with a geotextile and 6 inches of crushed stone to protect the subgrade from disturbance. Alternatively, place a 4-inch-thick concrete mud mat

over the subgrade to protect it.

- H. Subgrade Preparation on Slopes: Where embankment is to be placed against existing earth slopes steeper than 3 to 1, the slope shall be broken up into steps as the fill is placed in order to provide a suitable bond between the existing ground and the new embankment. Both the material cut out and the bottom of the area cut shall be compacted along with and to the same degree as the material being placed in the embankment. An exception to this is where existing stone on the reservoir slopes is kept in place.

3.3 EXCAVATION SUPPORT

- A. Slope sides of excavations to comply with OSHA regulations. Shore and brace, or use trench boxes, where sloping is not feasible because of space restrictions or slope instability.
- B. Do not excavate below a line drawn downward at 2 horizontal on 1 vertical from the underside of the closest edge of any proposed or in-place footing or utility at a higher elevation without providing adequate shoring and bracing to prevent loss of support of the footing or utility.

3.4 COMPACTION

- A. Compact soil to not less than the following percentages of maximum dry density determined in accordance with ASTM D1557, Method C. Compact soil using the lift thicknesses indicated.
 - 1. Crushed Stone: Compact to an unyielding surface or until further compaction results in no additional densification.
 - 2. Pavement Subbase, Select Fill, and Structural Fill: 95% compaction in 9-inch lifts.
 - 3. Ordinary Borrow and On-Site Fill: 90% compaction in 12-inch lifts (9-inch lifts above utilities and for compactors weighing less than 500 pounds).
- B. Moisture Control: Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content for all soils.

3.5 BACKFILL

- A. Place acceptable soil material in layers to required subgrade elevations for each area classification shown in the drawings.
- B. Backfill excavations as promptly as work permits, but not until completion of the following:
 - 1. Inspection, testing, approval, and recording locations of underground utilities.
 - 2. Removal of concrete formwork.
 - 3. Removal of shoring and bracing, and backfilling of voids with satisfactory materials.
- C. Placement of Fill:
 - 1. Do not place fill on surfaces that are muddy, frozen, or contain frost or ice.

2. Place fill evenly adjacent to structures to required elevations. Take care to prevent wedging action of fill against structures by carrying material uniformly around structure to approximately same elevation in each lift.
3. Brace subgrade walls before placing fill against the walls.

3.6 FROST PROTECTION

- A. Do not excavate to full depth when freezing temperature may be expected unless intended improvements can be accomplished immediately after the excavations have been completed. Protect subgrades from frost if progress is delayed. Do not install foundations or slabs on frozen ground. Protect the subsurface of in-place foundations from frost. Should protection fail, remove frozen materials and replace with concrete or Structural Fill as directed at no cost to the Owner.
- B. Keep the site clear and free of accumulations of snow as necessary to carry out the work.
- C. Do not use fill materials containing snow, frost, or frozen soil, and do not backfill over frozen material.
- D. Protect the underside of all in-place construction from frost penetration. Provide frost protection for all in-place foundations and slabs during all periods of freezing temperatures until such time as the entire project is complete. Provide, as a minimum, frost protection consisting of a 3.5-foot thickness of earth or equivalent in insulating properties.

3.7 GRADING

- A. Uniformly grade areas within limits of grading under this section including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated, or between such points and existing grades.
- B. Rough grading shall include the shaping, trimming, rolling, and refinishing of all surfaces of the subbase, shoulders, and earth slopes, and the preparation of grades as shown on the Drawings. Rough grade shall be the top surface of gravel, crushed stone and ordinary borrow ready to receive the final surface material application.
- B. Unless stated otherwise, all rough grades shall represent compacted material depths, as specified herein. Slope finish grades to drain surface water away from buildings, and other structures. Slope finish grades to drain surface water away from walks, paving, pools, or fountains unless otherwise shown on drawings. Generally, grade with uniform slope between points where elevations are given or between points and existing grades.
- C. The grading of shoulders and sloped areas may be done by machine methods. All ruts shall be eliminated. Traffic of men and equipment across soil subgrade areas shall be prohibited following excavation to the required lines and grades.
- D. In the case of lawn and planting areas, compaction requirements for subgrades and fills shall be considered minimums and maximums within the density percentages called for, and any over-compaction of subgrades or fills which would be detrimental to lawn or planting objectives shall be corrected by loosening subgrades or fills through tilling or other means and re-compacting to specified compaction limits.

3.8 FINE GRADING AND LOAMING

- A. Contractor shall obtain written approval from the Owner's Representative of previously completed rough grading work prior to commencing loam placement work. Prior to spreading of loam, subgrades which are too compact to drain water or are too compact based upon compaction tests shall be ripped with a claw twelve inches (12") deep, pulled by a bulldozer 2'-0" on center, both directions. Contractor shall then regrade surface.
- B. Immediately prior to dumping and spreading the loam, the subgrade shall be cleaned of all stones greater than two inches (2") and all debris or rubbish. Such material shall be removed from the site.
- C. Loam or topsoil shall be placed and spread over approved areas to a depth sufficiently greater than four inches (4") so that after natural settlement and light rolling, a minimum four inch (4") compacted loam depth will have been provided and the completed work will conform to the lines, grades and elevations indicated. Supply additional loam, after testing and approval, as may be needed to give the specified depths and finished grades under the contract without additional cost to the Owner.
- D. Disturbed areas outside the limit of seeding shall be spread with a minimum of four inches (4") of loam to the finished grade.
- E. No subsoil or loam shall be handled in any way if it is in a wet or frozen condition.
- F. Sufficient grade stakes shall be set for checking the finished grades. Stakes must be set in the bottom of swales and at the top of slopes. Grades shall be established which are accurate to one-tenth of a foot (1/10') either way. Connect contours and spot elevations with an even slope.
- G. After loam has been spread, it shall be carefully prepared by scarifying or harrowing and hand raking. Remove all large stiff clods, lumps, brush, roots, stumps, litter and other foreign matter. Remove all stones over one inch (1") in diameter from the top three inches (3") of the loam bed. Loam shall also be free of smaller stones in excessive quantities as determined by the Owner's Representative.
- H. The whole surface shall then be compacted with a roller or other suitable means to achieve a maximum dry density of 88 to 90 percent for the placed loam in accordance with compaction standards of ASTM D1557 Method D. During the compaction process, all depressions caused by settlement or rolling shall be filled with additional loam and the surface shall be regraded and rolled until presenting a smooth and even finish corresponding to the required grades.

3.9 CONSTRUCTION SURVEYS

- A. After clearing and grubbing, the contractor shall prepare a pre-construction survey of the limit of work area. The survey shall consist of 2 foot topographical survey at 1" = 40' scale and shall be submitted in an electronic format acceptable to the Owner's Representative.
- B. Contractor shall prepare a post-excavation survey of the limit of work area. Survey will reflect subgrade elevations. Volume calculations (cut to fill) shall be provided to the Owner's Representative.
- C. Contractor shall prepare and as-built post-construction survey of the entire site. The survey shall consist of 2 foot contour interval topographical survey at 1" = 40' scale and shall be submitted in an electronic format acceptable to the Owner's Representative. The survey shall provide the following features for the entire property: finished topography, utilities,

property lines, benches, paths, fences and other features. The as-built survey of the completed construction project shall be signed and stamped by a Massachusetts Registered Land Surveyor.

3.9 FIELD QUALITY CONTROL

- A. Quality Control Testing During Construction: Allow Owner's Representative to test and observe subgrades and backfill layers before further construction work is performed.
- B. If, in opinion of Owner's Representative based on testing and observation, fills have been placed below specified percent compaction, provide additional compaction at no additional expense.

3.10 PROTECTION AND REPAIR

- A. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades in settled, eroded, and rutted areas to specified tolerances.
- C. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required percent compaction prior to further construction.

3.11 DISPOSAL OF EXCESS SOILS AND WASTE MATERIALS

- A. Legally dispose of excess soil and other waste materials off site. Previous investigations have not indicated the presence of oil or other hazardous materials at concentrations that would be classified as a reportable condition under the Massachusetts Contingency Plan (310 CMR 40.0000).
- B. Submit proposed disposal location(s), including written approval by the receiving facility. After soils are disposed, submit receipts for the soils prepared by the receiving facility.

END OF SECTION

SECTION 312500

EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and relevant sections of these Specifications, apply to the work specified in this Section.

1.02 SUMMARY

- A. The work of this Section shall consist of the erosion and sediment control devices to minimize erosion and siltation during construction as indicated on the Drawings and/or as specified herein.

1.03 RELATED WORK UNDER OTHER SECTIONS

- A. The following items of related work are specified and included in other Sections of the Specifications:
 - 1. Section 024113 – Site Preparation and Demolition.
 - 2. Section 310000 – Earthwork.

1.04 EXAMINATION OF CONDITIONS

- A. The Contractor shall fully inform him/herself of existing conditions of the site
- B. Plans, surveys, measurements and dimensions under which the work is to be performed are believed to be correct to the best of the Owner's Representative's knowledge.

1.05 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product Data: Submit manufacturer's technical product data and installation instructions for siltation control materials and products.

PART 2 - PRODUCTS

2.01 PRODUCTS

- A. Sediment control fabric for catch basins
 - 1. Sediment control fabric shall be UV resistant woven polypropylene fabric and must be manufactured to fit catch basin opening.
 - a. Fabric shall have a minimum Grab Strength of 265 lbs., minimum puncture of 120 lbs, and permittivity of 0.5 to 1.5 sec-1.
 - b. Sediment control fabric must have integral lifting system to aid removing the fabric from the drain structure.
- B. Sediment control and erosion control barriers

1. Hay bales - Hay bales to be new, firm, nylon-bound livestock feed-grade. Hay bales to be installed with ends butted tightly together. Provide two stakes per hay bale. Stake are 4 foot long and driven a minimum of one foot into the ground.
2. Silt fence – Posts should be spaced a maximum of 6 feet apart. The bottom edge of the geotextile is to be buried a minimum of 6 inches in a vertical trench with the soil pressed firmly against the embedded geotextile. A polyester or nylon cord (minimum diameter 1/8 inch) should be sewn into a seam running continuously along the top of the geotextile. Each post should be securely fastened to the geotextile by a minimum of five one inch-long gun staples suitable for this purpose. Staples should be diagonal to the threads of the geotextile fabric.

C. Rock Construction Entrance

1. Gravel: Conform to the requirements of Massachusetts Highway Department (MHD) Standard Specifications for Highways and Bridges, Section M1.03.0 Type C.
2. Non-woven geotextile: Refer to Section 310000 Earthwork, Separation Non-woven Geotextile.

PART 3 - EXECUTION

3.01 GENERAL EROSION AND SEDIMENT CONTROL

- A. Retain sediment on-site
- B. Refer to Drawings for locations of erosion and sediment controls.
- C. The areas of the rock construction entrances should be cleared of all vegetation, roots, and other objectionable material. The gravel shall be placed to the specified dimensions noted on the Drawings.
- D. Erosion control devices shall be installed, inspected, and approved by the appropriate authority prior to the start of site clearing and grubbing operations.
- E. Maintain erosion control inspection reports in accordance with all local, state and federal requirements and the construction documents.

3.02 MAINTENANCE AND REMOVAL OF EROSION CONTROL DEVICES

- A. Erosion Control Devices:
 1. Check sediment behind the erosion control devices and in catch basins twice a month and after each rain event of one half inch or greater. Remove silt if greater than 6 inches deep at erosion control devices. Empty sediment control fabric in catch basins when $\frac{3}{4}$ full.
 2. Maintain erosion control devices in place and in effective condition. The underside of hay bales must be in close contact with the earth below at all times to prevent water from washing beneath them.
 3. The rock construction entrances shall be maintained in a condition, which will prevent tracking or flowing of sediments onto public right-of-ways. This will require periodic top dressing with additional stone, or additional length, as conditions demand, and repair, and/or cleanout of any measures used to trap sediment. All sediment spilled, dropped, washed, or tracked onto public right-of-ways must be removed immediately.
 4. The Contractor shall perform all operations and maintenance for erosion control in accordance with all local, state and federal requirements and the construction documents.

3.03 DISPOSAL AND CLEANUP

- A. Maintain erosion control devices until all disturbed earth has been paved or vegetated and the site has been inspected and approved by the local authorities.
- B. After removing erosion control devices regrade and seed or stabilize areas disturbed by these devices.

END OF SECTION

SECTION 321216

BITUMINOUS CONCRETE PAVEMENT

PART - 1 GENERAL

1.1 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and relevant sections of these Specifications, apply to the work specified in this Section.

1.2 RELATED SECTIONS

- A. Related sections include, but are not limited to, the following:
 - 1. Section 310000 Earthwork
 - 2. Section 321313 Concrete Paving

1.3 SUMMARY

- A. Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:
 - 1. Pedestrian and Vehicular Bituminous Concrete including base preparation.

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.". References made to particular sections or paragraphs in the Standard Specifications shall include all related articles mentioned therein.
 - 2. ASTM: American Society for Testing and Materials.
 - 3. AASHTO: American Association of State Highway and Transportation Officials.

1.5 SUBMITTALS

- A. Provide Test Reports and Certificates of Compliance for all materials provided under this section.

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 a lack of knowledge of existing conditions as indicated in the Contract Documents, or obvious from observation of the site.
- B. Plans, surveys, measurements and dimensions under which the work is to be performed are believed to be correct, but the Contractor shall have examined them for himself during the bidding period and formed his own conclusions as to the full requirements of the work involved.

PART - 2 PRODUCTS

2.1 COMPACTED GRAVEL BASE COURSE AND SUBBASE PREPARATION

- A. Compacted gravel shall be used as a base course material under pavements.
- B. Compacted gravel shall consist of inert material that is hard, durable stone and coarse sand free from loam, clay, surface coatings, other organic material and deleterious materials. The maximum size of stone gravel shall be three (3) inches in the largest dimension. The materials shall meet the Massachusetts DOT Standard Specifications for "Gravel Base Course".
- C. Reuse of existing gravel base course materials shall not be permitted unless the existing material is tested by an approved independent laboratory and is certified to meet the Massachusetts DOT Standard Specifications for "Gravel Base Course".
- D. The approved source of gravel material shall be processed by mechanical means. The equipment for producing crushed gravel shall be of adequate size and with sufficient adjustments to produce the desired materials.
- E. Compacted subbase shall conform to Section 310000 – Earthwork.

2.2 BITUMINOUS CONCRETE

- A. General: Use locally available materials and gradations that exhibit a satisfactory record of previous installations.
- B. Coarse Aggregate: Sound, angular crushed natural rock complying with Section M3.11.04 of the Standard Specifications.
- C. Fine Aggregate: Natural sand, stone sand, blend of sand and stone screenings or, blend of natural sand and stone sand complying with Section M3.11.04 of the Standard Specifications.
- D. Mineral Filler: Rock dust, slag dust, hydrated lime, hydraulic cement, or other inert material complying with Section M3.11.05 of the Standard Specifications and ASTM D242.
- E. Asphalt Cement: Complying with Section M3.01.0 of the Standard Specifications and ASTM D3381 for viscosity-graded material.

- F. Prime Coat: Cut-back asphalt type, complying with Section M3.02.0 of the Standard Specifications and ASTM D2027, MC-30, MC-70 or, MC-250.
- G. Tack Coat: Emulsified asphalt, complying with Section M3.03.0 or M3.03.1 of the Standard Specifications and ASTM D977 or ASTM D2397; SS-1, SS-1h, CSS-1 or CSS-1h.
- H. Provide plant-mixed binder course and top course mixtures complying with Section M3.11.00 of the Massachusetts Standard Specifications.
- I. Bituminous Concrete shall consist of binder mix for base course and dense mix for top course constructed to the thicknesses shown on the plans and shall conform to the relevant provisions of Sections 460 and (M3.11.03) of the Commonwealth of Massachusetts Highway Department, Standard Specifications for Highways and Bridges, latest edition.

PART - 3 EXECUTION

3.1 GENERAL

- A. Subbase under paving shall be compacted to a minimum of 95 percent. Add material meeting the requirements of ordinary borrow to bring the subgrade to the required grade as necessary before placing base course.
- B. The gravel base course shall be spread in layers upon the prepared subgrade conforming to the required line and grade. Gravel shall be placed in compacted layers not more than 4 inches thick compacted to not less than 95 percent of the maximum dry density of the material. Any stone greater than 3 inches in size shall be removed. Compaction shall continue until the surface is even and true to line and grade.
- C. Gravel base course shall be placed on backfilled and compacted trenches to proper grade before placement of pavement.
- D. The edges of existing pavement that is to remain shall be saw cut to an even, straight edge using a power-driver rotary saw; use of a jackhammer is unacceptable. This includes road, parking lot, sidewalk, and utility trench edges.
- E. Bituminous concrete courses shall be spread and compacted to the finished thicknesses as shown on the Contract Drawings. A smooth even surface shall be produced.
- F. Any joints at junctions of old and new pavements shall be sealed with a hot poured rubber asphalt sealer and covered with sand.
- G. Contractor shall apply prime and tack coats when the ambient temperature is above 50 degree F (10 degrees C), and when temperature has not been below 35 degrees F (1 degree C) for 12 hours immediately prior to application.

3.2 SURFACE PREPARATION

- A. Proof Roll the prepared subbase. Do not begin paving work until deficient subbase areas have been corrected and are ready to receive paving.

3.3 PLACING MIX

- A. General: Spread bituminous concrete mixture on prepared surface, spread and strike-off. Spread mixture at minimum temperature of 225°F (107°C). Place inaccessible and small areas by hand. Place each course to required grade, cross-section, and compacted thickness. Protect all adjacent construction from staining with mix or damage by mechanical equipment. Clean, repair or replace any construction stained or damaged at no additional cost to the Owner.
- B. Paver Operation: Spread bituminous in strips not less than 10-feet wide, unless otherwise acceptable to Engineer. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete base course for a section before placing surface course.
- C. Joints: Make joints between old and new pavements, or between successive days' work, to ensure continuous bond between adjoining work. Construct joints to have same texture, density and smoothness as other sections of bituminous concrete course. Clean contact surfaces and apply Hot Poured Rubberized Asphalt Sealer.
- D. Coat surfaces of watergate covers, gas gate covers, manhole covers and catch basin grates with a release agent to prevent bond with asphalt pavement.
- E. The equipment for spreading bituminous concrete shall be mechanical, self-powered pavers capable of spreading and finishing the mixture true to line, grade, width, and crown by means of fully automated controls for both longitudinal and transverse slope.
- F. The pavers shall operate while bituminous mixture is being spread at a speed that will produce a uniform surface texture free of any rippling or unevenness.
- G. The mixtures shall be placed and compacted only at such times as to permit the proper inspection and checking by the Engineer.
- H. The mixtures shall only be placed in the work when they can be efficiently and satisfactorily placed by the methods stipulated herein. Unless otherwise permitted by the Engineer for special conditions, only machine methods of placing shall be used.
- I. No mixture shall be placed unless the breakdown and intermediate rolling can be completed by the time the material has cooled to 170°F and provided that the density of the completed pavement attains at least 95 percent of the laboratory compacted density.
- J. The mixtures shall be placed only upon approved surfaces that are clean from foreign materials and dry and when weather conditions are suitable. The Engineer may, however, at the entire responsibility of the Contractor, permit work to continue when overtaken by sudden rain, but only with material that may be in transit from the plant at the time and then only when the temperature of the

mixture is within the temperature limits specified and the existing surface on the roadway is not excessively wet.

- K. The bituminous concrete shall be placed in course depths as shown in the Contract Drawings, as specified and as directed by the Engineer.
- L. When an existing surface or new base upon which the bottom course is to be placed contains unsatisfactory irregularities, in the Engineer's judgment, such irregularities shall be eliminated by an adequate placing and compaction of mixture so as to furnish a surface with true contour and grade before placing any specified course of mixture.
- M. Special attention shall be given to proper testing of the surface of each course with a straightedge. The finished surfaces shall be even and uniform throughout.
- N. Any mixture that becomes loose or broken, mixed with dirt, or in any way defective shall be removed and replaced with new mixture that shall be compacted to conform to the surrounding area. Areas of one square foot or more showing an excess of bitumen shall be removed and replaced.
- O. Immediately after any course is screened and before roller compaction is started, the surface shall be checked, any irregularities adjusted, any accumulation from the screed removed by rake or lute, and all fat spots in any course removed and replaced with satisfactory material. Irregularities in alignment and grade along outside edges shall be corrected by the addition or removal of mixture before the edges are rolled. Indiscriminate casting of mix on the new screened surface, where irregularities are not evident, shall not be permitted.
- P. Spreading by hand methods will be permitted only for particular locations in the work that, because of irregularity, inaccessibility, or other unavoidable obstacles, do not allow mechanical spreading and finishing.

3.4 ROLLING

- A. General: Begin rolling when mixture will bear roller weight without excessive displacement.
- B. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.
- C. Breakdown Rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling, and repair displaced areas by loosening and filling, if required, with hot material.
- D. Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.
- E. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.

- F. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut-out such areas and fill with fresh, hot bituminous concrete. Compact by rolling to match the surrounding surface density and smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked by wheel traffic.
- I. After the paving mixture has been properly spread, initial compaction shall be obtained by the use of power rollers. The rollers shall be steel wheeled supplemented with pneumatic-tired rollers where required or where permitted by the specifications, vibratory rollers.
- J. Steel wheel rollers for initial and intermediate rolling shall have a weight of not less than 240 pounds per inch width of tread.
- K. Each roller shall be operated by a competent, experienced roller operator and shall be kept in as nearly continuous operation as practicable while work is underway. The mixture shall be rolled longitudinally, diagonally, and transversely as may be necessary to produce the required contour for surface. Longitudinal rolling shall start at the side and proceed toward the center of the pavement, except on superelevated pavements where the rolling shall begin on the low side and progress to the high side, overlapping on successive trips by at least 12 inches. The rolling shall be continued and so executed that all roller marks, ridges, porous spots, and impressions are eliminated and the resulting surface has the required grade and contour. The motion of the rollers shall at all times be slow enough to avoid any displacement of the hot mixture. Any displacement or marring of the surface occurring as a result of reversing the direction of the rollers, or from any other cause, shall be corrected. To prevent adhesion with the mixture, the wheels of the steel rollers shall be kept lightly moistened with water, but excess water will not be permitted. The use of oil for this purpose will not be allowed.
- L. Along curbs, structures, and all places not accessible with a roller, the mixture shall be thoroughly compacted with mechanical tamping devices. The surface of the mixture after compaction shall be smooth and true to the established line and grade.
- M. Placing of the mixture shall be as nearly continuous as possible and the roller shall pass over the unprotected end of the newly placed mixture only when the placing of the course is to be discontinued for such length of time as would permit the mixture to attain initial stability. In all such cases, including the formation of joints, provision shall be made for proper bond with the new surface for the full specified depths of the courses.
- N. The maximum length of longitudinal joint shall be such that the temperature of the mixture of the joint shall be not less than 200°F when abutting mixture is placed.

- O. If the paving sequence or other conditions cause the joint temperature to fall below 200°F, the joint shall be treated prior to laying the next lane of bituminous concrete as follows:
 - 1. The joint shall be coated with a hot poured rubberized asphalt sealant meeting the requirements of Federal Specification SS-S-1401 or SS-S-164.
- P. Longitudinal and transverse joints shall be made in a careful manner, well bonded and sealed, and true to line and grade.
- Q. In making joints along any adjoining edge, such as curb, gutter, or an adjoining pavement, and after the mixture is placed by the mechanical spreader, just enough of the hot material shall be placed by hand method to fill any space left open. These joints shall be properly "set-up" with the back of a rake at the proper height and level to receive the maximum compaction. The work of "setting-up" these joints shall be performed only by competent workmen.
- R. Where and as directed, the first width of any course shall be placed not less than 1 foot wider than the first width of top course and successive widths of top and as any other courses shall be so placed that there will be at least a 1-foot overlap between the joints in the top course and the other course.
- S. The rolling of the successive widths of courses shall overlap and shall be performed so as to leave smooth, uniform joints and cross-sections.

3.5 FIELD QUALITY CONTROL

- A. Test in-place asphalt and cement concrete courses for compliance with tolerance requirements. Repair or remove and replace unacceptable paving as directed by Engineer. In-place surfaces will not be acceptable if exceeding the allowable variation from the following required tolerances:
 - 1. Thickness: Plus ¼-inch.
 - 2. Sidewalk Elevation: ⅛-inch, plus or minus.
 - 3. Roadway Elevation: ¼-inch, plus or minus.
 - 4. Expansion Joint Width: Plus ⅛-inch.
 - 5. Surface: Gap below 10-foot-long straightedge, ⅛-inch.
- B. The Contractor is responsible for ensuring that the grade at accessible curb cuts, sidewalks, and parking spaces does not exceed Massachusetts Architectural Access Board requirements CMR 521.
- C. 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 Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods, ASTM 2950 at the Contractor's expense.

- D. Guarantee: During the one 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 holes that may occur so as to keep the surfacing in a safe and satisfactory condition for traffic.

END OF SECTION

SECTION 321313
CONCRETE PAVING

PART - 1 GENERAL

1.1 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and relevant sections of these Specifications, apply to the work specified in this Section.

1.2 SUMMARY

- A. Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:
 - 1. Pedestrian Depth Concrete Pavement-Broom Finish:
 - a. Color and aggregate to be coordinated with and to match finishes specified within Architectural Concrete and Cast Stone Specifications. Performance of finishing shall be executed so that results match design reference samples and mock-ups as well as retained samples of historic exposed aggregate finishes, as approved by Owner's Representative.
 - 2. Reinforcement for Concrete Pavement

1.3 RELATED SECTIONS

- A. Related Sections include, but are not limited, to the following:
- B. Section 024100 "Selective Demolition" for the retention and protection of the following items:
 - 1. Retain and protect a minimum of six (6) representative samples of historic exposed aggregate finishes for sourcing of materials and for comparison to reference samples and mock-ups submitted for approval as required by these Specifications. Three (3) of the six (6) samples shall be provided to the precast and cast stone fabricator; three (3) of the six (6) samples shall be provided to the Owner's Representative.
- C. Section 033300 Architectural Concrete
- D. Section 034100 Structural Precast Concrete and Unit Cast Stone

1.4 REFERENCES

- A. ANSI/ASTM A185 - Welded Steel Wire Fabric for Concrete Reinforcement

- B. ANSI/ASTM A497 - Welded Deformed Steel Wire Fabric for Concrete Reinforcement
- C. ANSI/ASTM D1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
- D. ASTM A 615 - Deformed and Plain Billet-Steel for Concrete Reinforcement
- E. ASTM C33 - Concrete Aggregates
- F. ASTM C94 - Ready Mixed Concrete
- G. ASTM C150 - Portland Cement
- H. ASTM C260 - Air-Entraining Admixtures for Concrete
- I. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete
- J. ASTM C494 - Chemical Admixtures for Concrete
- K. FS TT-C-800 - Curing Compound, Concrete, for New and Existing Surfaces

1.5 QUALITY ASSURANCE

- A. Perform work in accordance with ACI 301.
- B. Obtain materials from same source throughout.
- C. Sample and test concrete during placement of concrete as follows:
 - 1. Sampling Fresh Concrete: ASTM C172; except modified for slump to comply with ASTM C94.
 - 2. Slump: ASTM C143; one test for each concrete load at point of discharge and one for each set of compressive strength test specimens.
 - 3. Air Content: ASTM C231; pressure method; one for each set of compressive strength specimens.
 - 4. Compressive Strength Tests: ASTM C39; one (1) set for each 150 cubic yards (115 cubic meters) or fractions thereof, of each concrete class placed in any one day or for each 5000 sq. ft. (465 square meters) of surface area placed; two (2) specimens tested seven (7) days, three (3) specimens tested 28 days and one (1) specimen retained in reserve for later testing if required

1.6 REGULATORY REQUIREMENTS

- A. Conform to applicable code for paving work on public property.
- B. Submit proposed mix design to Landscape Architect for review prior to commencement of work.
- C. Tests of cement and aggregates will be performed to ensure conformance with requirements stated herein.
- D. Three concrete test cylinders will be taken for every 75 or less cubic yards (57 or less cubic m) of concrete placed each day.

- E. One additional test cylinder will be taken during cold weather and be cured on site under same conditions as concrete it represents.
- F. One slump test will be taken for each set of test cylinders taken.

1.7 SUBMITTALS

- A. Submit product data under provisions of the General Conditions.
- B. Submit manufacturer's instructions under provisions of the General Conditions.
- C. Product Data: Submit product data for the following materials and items.
 - 1. Concrete Design Mix
 - 2. Reinforcement
 - 3. Joint Filler
 - 4. Primer and Sealant for Expansion Joints
 - 5. Forming Accessories
 - 6. Admixtures
 - 7. Patching Compounds
 - 8. Sealants
 - 9. Show bar schedules, stirrup spacing, diagrams of bent bars and arrangement of reinforcement including bar overlap.
 - 10. Include special reinforcement required for openings through concrete structures.
 - 11. Laboratory Test Reports: Submit concrete materials test reports and mix design reports certifying that each material or item complies with or exceeds the specified requirements.

1.8 SAMPLES AND MOCK UP

- A. Samples: Submit samples of 1. Machine-chipped granite aggregate and 2. Portland cement concrete design mix colors.
- B. Mock-up Panels: Prepare one mock-up panel for each paving type (Medium Broom Finish) including score joints at the project site to demonstrate proficiency of the workmen, and define the texture of the finish. Mock-up panels shall be a minimum of 5'-0" x 5'-0". Contractor shall use the methods and materials proposed for use on the final installation. Uniformity in appearance of each panel shall be the responsibility of the Contractor. The approved mock-up shall serve as a standard of appearance for the final work.

PART - 2 PRODUCTS

2.1 CONCRETE MATERIALS

- A. Cement: ASTM C150 Normal-Type I Portland type, gray color.
- B. Fine and coarse Aggregates: ASTM C33
- C. Fiber reinforcing to be added per manufacturer's recommendations.
- D. Water: Clean and not detrimental to concrete

2.2 COLOR ADMIXTURE AND CURING COMPOUND

- A. Color admixture for integrally colored concrete surfaces shall be a colored, water-reducing, admixture containing no calcium chloride with coloring agents that are limeproof and ultra-violet resistant. Colored admixture shall conform to the requirements of ACI 303.1, ASTM C979, ASTM C494 and ASSHTO M194.
 - 1. Color admixture shall be equal to the following, and as approved by Architect:
 - 1.) CHROMIX P Admixture and CHROMIX ML, as manufactured L. M. SCOFIELD COMPANY, Douglasville, Georgia and Los Angeles, California (800) 800-9900 or the appropriate local contact: Eastern Division – 201-672-9050; Western Division – 323-720-3055; Central Division Office – 630-377-5959.
 - 2. Concrete Color: As selected by Landscape Architect from manufacturer's color chart.
- B. Curing compound for integrally colored concrete surfaces shall comply with ASTM C309 and be of same manufacturer as colored admixture, for use with integrally colored concrete.
 - 1. Curing compound shall be equal to the following, and as approved by Architect:
 - 1.) LITHOCHROME COLORWAX, as manufactured L. M. SCOFIELD COMPANY, Douglasville, Georgia and Los Angeles, California (800) 800-9900 or the appropriate local contact: Eastern Division – 201-672-9050; Western Division – 323-720-3055; Central Division Office – 630-377-5959.
 - 2. Color to match integrally colored concrete.

2.3 FORM MATERIALS

- A. Unless otherwise indicated, construct formwork with plywood, metal, metal framed plywood faced or other acceptable panel type materials to provide continuous, straight, smooth, exposed surfaces.
 - 1. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without bow or deflection.
 - 2. Provide forms that comply with US Product Standard PS 1 and the following:
 - a. B-B High Density Overlaid Concrete Form, Class I.
 - b. B-B (Concrete Form) Plywood, Class I, exterior grade or better, mill oiled and edge sealed, with each piece bearing legible inspection trademark.
- B. Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.
- C. Form Ties: Provide factory-fabricated, adjustable-length, removable or snapoff metal form ties, designed to prevent form deflection, and to prevent spalling concrete surfaces upon removal.

1. Unless otherwise indicated, provide ties so portion remaining within concrete after removal is at least 1/2 inch (12.7 mm) inside concrete for steel ties and 1/4 inch (6.35 mm) for wire ties.
2. Unless otherwise indicated, provide form ties which will not leave holes larger than 1 inch (25 mm) diameter in concrete surface.

2.4 REINFORCEMENT

- A. Cold-drawn steel wire: ASTM A82.
- B. Welded wire fabric: ASTM A185, welded steel wire fabric. Furnish in flat sheets, not rolls, unless rolls are acceptable to the SDR.
- C. Reinforcing Bars: ASTM A615, deformed.
 1. Provide Grade 40 bars No. 3 and 4 for stirrups and ties.
 2. Provide Grade 60 bars No. 3 to 18, except as otherwise noted.
- D. Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place.
 1. Use wire bar type supports complying with CRSI recommendations, unless otherwise indicated. Do not use wood, brick, stone, broken block or pieces of concrete.
 2. For concrete-on-grade, use supports with sand plates or horizontal runners if base material will not adequately support chair legs.
 3. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are plastic protected, stainless steel protected, or special stainless complying with CRSI Classes, C, D, or E respectively.
- E. Shop fabricate reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances complying with ACI 315. In case of fabricating errors, do not rebend or straighten reinforcement in manner that will injure or weaken material

2.5 ACCESSORIES

- A. Curing Compound: SF TT-C-800, Type 1, 30 percent solids.
- B. Preformed Joint Filler and Backer Rod: Expanded polyethylene joint filler and backer rod, as manufactured by A. H. Harris and Sons, Medfield, Mass. or approved equal.
- C. Sealant shall be "Sikaflex-1A" as manufactured by Sika Corporation, Lyndhurst, New Jersey or approved equal. Sealant shall be in accordance with Federal Specification TT-S-00230C, Type II, Class A and ASTM C-920, Type S, Grade NS, Class 25.

2.6 ADMIXTURES

- A. Air Entrainment: ASTM C260.

- B. Use accelerating admixture in cold weather only when approved by Landscape Architect. Use of admixture will not relax cold weather placement requirements.
- C. Use set-retarding admixtures during hot weather only when approved by Landscape Architect.
- D. Use water-reducing admixture in all concrete.
- E. Use air-entraining admixture in exterior exposed concrete.

2.7 CONCRETE MIX

- A. Mix concrete in accordance with ASTM C94.
- B. Provide concrete of the following characteristics:
 - 1. Compressive Strength of 28 days: 4500 psi (276 mPa). Slump: of 3 inches
 - 2. Air Content: Between 5% and 7%
- C. Coloring Agent: Add coloring agent to mix according to manufacturer's written instructions.

PART - 3 EXECUTION

3.1 INSPECTION

- A. Verify compacted subgrade and base is ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are as shown on the drawings.
- C. Beginning of installation means acceptance of existing conditions

3.2 PREPARATION

- A. Remove water from excavations. Before placement of concrete, remove wood chips, shavings, and hardened concrete from forms.
 - 1. Clean all equipment.
 - 2. Wet forms, except in freezing weather, or oil forms.
- B. Earth shall be uniformly moist when concrete is placed. Sprinkling method shall not be such as to form mud or pools of water. Watering subgrade immediately prior to placing concrete is not sufficient to make the soil uniformly moist.
- C. Notify other crafts to permit installation of their work. Coordinate installation of joint materials and moisture barriers with placement of forms and reinforcing steel.
- D. Notify Landscape Architect a minimum of 24 hours prior to commencement of concreting operations.

3.3 FORMING

- A. Design, erect, support, brace and maintain formwork to support vertical and lateral loads that might be applied until such loads can be supported by concrete structure.
- B. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation and position.
- C. Design and fabricate formwork to be readily removable without impact, shock or damage to cast-in-place concrete surfaces and adjacent materials.
- D. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades.
- E. Tolerances: Set forms with the upper edge true to line and grade with an allowable tolerance of 1/8 inch (3 mm) in any 10 foot (3 m) long section
- F. Tolerances: Set forms with the upper edge true to line and grade with an allowable tolerance of 1/8 inch (3 mm) in any 10 foot (3 m) long section

3.4 REINFORCEMENT

- A. Comply with CRSI's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, oil, concrete splatter from previous pours, and other materials which reduce or destroy bond with concrete.
- C. Accurately position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.
- D. Install welded wire fabric of same gage in as long of lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps of adjacent widths to prevent continuous laps in either direction.
- E. Interrupt reinforcement at expansion joints.
- F. Place reinforcement to achieve slab and curb alignment as detailed.

3.5 JOINTS

- A. Place expansion joints at 20 foot maximum intervals or as shown on plan to correct elevation and profile. Align sidewalk joints.
- B. Place joint filler and sealant where pavement meets curbing or structures including building, light bases, hydrants, and at other conditions as shown on drawings.
- C. Install galvanized steel dowels on 18" centers where expansion joints are located.
- D. Provide saw-cut control joints at 5 foot intervals maximum of sidewalk, or as shown on plan.

- E. Apply joint sealer where indicated on drawings. Apply in accordance with manufacturer's instructions.

3.6 PLACING CONCRETE

- A. Field Inspection: Do not place concrete until forms and reinforcing steel have been inspected and approved.

Below 40 degrees F (4 degrees C)

See Cold Weather Placing

- 1. Place Ready-Mix concrete within specified time after batching.

40 - 85 degrees F (4 - 29 degrees C) 90 minutes

86 - 90 degrees F (30 - 32 degrees C) 75 minutes

Above 90 degrees F (32 degrees C) 60 minutes

- 2. Adding Water: Do not add water after initial introduction of mixing water for batch except when slump of concrete is less than that specified upon arrival at job site, and maximum water/cement ratio for mix has not been exceeded

- a. Add water to bring slump within specified limits. Turn drum at least 30 additional revolutions at mixing speed. Do not add water to batch at any later time.
- b. Insure that concrete strength meets specified requirements, and water does not exceed maximum amount specified in CONCRETE MIX DESIGN.

- B. General: Comply with ACI 304, and as specified herein.

- 1. Deposit concrete continuously or in layers of such thickness that concrete will not be placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness.
- 2. If section cannot be placed continuously, provide construction joints. Deposit concrete as nearly as practicable to its final location to avoid segregation.

- C. Placing concrete in forms

- 1. Consolidate placed concrete by high frequency mechanical vibrating equipment, supplemented as necessary by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.
 - a. Do not use vibrators to transport concrete inside forms.
 - b. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine.
 - c. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing segregation of mix.

- D. Placing Concrete Slabs: Deposit and consolidate concrete slabs in continuous operation, within limits of construction joints, until placement of panel or section is

completed. Maintain reinforcing in proper position during concrete placement operations.

- E. Placing Concrete Sidewalks & Pads: Place concrete in forms in one (1) layer of such thickness that when consolidated and finished, sidewalks will be of thickness indicated in drawings.
- F. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures; comply with ACI 306.
- G. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
- H. Ensure reinforcement, inserts, embedded parts and formed joints are not disturbed during concrete placement.
- I. Place concrete continuously between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.
- J. Place concrete to pattern indicated.

3.7 BROOM FINISHING

- A. Concrete shall have a Medium Broom, non-slip finish, saw-cut joints, tooled edge, and scored, as indicated on drawings.
- B. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.
- C. Liquid Chemical Hardener Finish: Apply chemical hardener finish after complete curing and drying of the concrete surface.
 - 1. Dilute liquid hardener with water, and apply in three (3) coats; first coat, 1/3 strength; second coat, 1/2 strength; third coat, 2/3 strength. Evenly apply each coat, and allow 24 hours for drying between coats.
 - 2. Apply proprietary chemical hardeners, in accordance with manufacturer's printed instructions.
 - 3. After final coat of chemical hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water.

3.8 CONCRETE PAVEMENT CURING AND PROTECTION

- A. Curing of the finished concrete surface shall be started as soon as it is possible to do so without damaging the surface. The surface shall be wetted or otherwise kept moist throughout a minimum six (6) day curing period through the use of a spray applied curing compound. The concrete surface shall be protected from all traffic or other disturbance during the curing period.
- B. Integrally Colored Concrete: Apply curing compound for integrally colored concrete according to manufacturer's instructions using manufacturer's recommended application techniques. Apply curing compound at consistent time for each pour to maintain close color consistency.

- C. Curing compound shall be same color as the colored concrete and supplied by same manufacturer of the colored admixture.
- D. The Contractor shall provide adequate surveillance for all poured-in-place concrete pavements until concrete has set firmly, to prevent unwarranted markings of the concrete surface. Any unauthorized marking or graffiti in the finished surfaces shall be a cause for rejection by the Landscape Architect and replacement by the Contractor.
- E. Adequate protection shall be provided where temperatures of forty degrees (40 degrees F.) or lower occur during placing of concrete, and during the early curing period. The minimum temperature of fresh concrete after placing, and for the first three (3) days shall be maintained above fifty-five degrees (55 degrees F). In addition to the above requirements, an additional three (3) days of protection from freezing shall be maintained.
- F. Precautions shall be taken in hot weather to prevent plastic cracking resulting from excessively rapid drying at the surface as described in CIP 5 Plastic Shrinkage Cracking published by the National Ready Mix Concrete Association.
- G. Do not cover concrete with plastic sheeting.

3.9 SAWCUTTING

- A. Provide sawcut joints with a penetration depth of minimum 1-inch between expansion joints, true and plumb to the paving surface, parallel to one another and perpendicular to paving edge and straight within a tolerance of ¼ inch of a straight edge laid along the joint. Use new saw blades to result in smooth and crisp cuts. Sawcuts shall optimally be performed 6-18 hours after concrete is placed. In no case shall this time exceed 24-hours

3.10 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 014500.
- B. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.
- C. Patching Defective Areas: Immediately cut out honeycomb, rock pockets, voids over 1/8 inch (6.35 mm) in any dimension, and holes left by tie rods and bolts, down to solid concrete but, in no case to a depth of less than one (1) inch (25 mm).
 - 1. Cut edges perpendicular to concrete surface.
 - 2. Thoroughly clean, dampen with water, and brush coat area to be patched with neat cement grout or proprietary bonding agent before placing cement mortar or proprietary patching compound.
- D. Remove and replace concrete with defective surfaces if defects cannot be repaired to satisfaction of Landscape Architect.
 - 1. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on surface, and stains and other discolorations that cannot be removed by cleaning.

- a. Dampen concrete surfaces in contact with patching concrete and brush with neat cement grout, or apply concrete bonding agent.
- b. Mix patching concrete of same materials to provide concrete of same type of class as original concrete.
- c. Place, compact and finish to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.

END OF SECTION

SECTION 323300

SITE FURNISHINGS

PART - 1 GENERAL

1.1 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and relevant sections of these Specifications, apply to the work specified in this Section.

1.2 EXAMINATION OF CONDITIONS

- A. The Contractor shall fully inform himself of existing conditions of the site before submitting his bid, and shall be fully responsible for carrying out all site work required to fully and properly execute the work of the Contract, regardless of the conditions encountered in the actual work. No claim for extra compensation or extension of time will be allowed on account of actual conditions inconsistent with those assumed.
- B. Plans, surveys, measurements and dimensions under which the work is to be performed are believed to be correct to the best of the Landscape 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 therein.

1.3 SUMMARY

- A. This Section includes, but is not limited to the following:

- 1. Cast Stone Planter Urn

1.4 QUALITY ASSURANCE

- A. Materials and methods of construction shall comply with the following standards:
 - 1. ASTM: American Society for Testing and Materials
 - 2. ANSI: American National Standards Institute
 - 3. FS: Federal Specifications
 - 4. BIFMA: Business and Institutional Furniture Manufacturer's Association
 - 5. PCI: Precast Concrete Institute
 - 6. PCA: Portland Cement Association
 - 7. Standard Specifications: Comply with the Commonwealth of Massachusetts, Massachusetts Highway Department, Standard Specifications for Highways and Bridges, 1995 Edition.
- B. Qualifications of Workers: Use adequate numbers of skilled workers who are trained in the necessary crafts and who are completely familiar with the specified requirements and methods needed for the proper performance of the work of this Section.

- C. Layout and Grading: After staking out the work, and before beginning final construction, obtain the Landscape Architect's approval for layout and grades. Contractor shall make adjustments as determined by the Landscape Architect. Landscape Architect may make adjustments to grades and layout as is required to meet existing and proposed conditions without additional cost to the contract price.

1.5 SUBMITTALS

- A. Samples: Prior to ordering the below listed materials, submit product color samples provided by manufacturer. Do not order materials until Architect's approval has been obtained. Delivered materials shall closely match the approved samples. Submit duplicate samples of each type listed below showing full range of color variation, finish and texture that can be expected in the permanent work:
 - 1. Finish and color samples for all site furnishings
- B. Shop Drawings: Shop Drawings shall show all details including sizes, materials, quantities and manner of assembling the various members, properly coordinated with the related work. Shop Drawings shall show true profiles, methods of anchoring hardware, if any, and all other necessary information. Work includes but is not limited to furnish and install:

- 1. Cast Stone Planter Urn

PART - 2 PRODUCTS

2.1 CAST STONE PLANTER URN

- A. Cast Stone Planter Urn shall be the Monteros Urn, as manufactured by Campania International, Inc, 2452 Quakertown Road Suite 100, Pennsburg, PA 18073, United States, (215) 541-4330. Or approved equal.
- B. Color: to match work specified within Cast Stone and Architectural Concrete Specifications, to be selected from manufacturer's standard color range.
- C. Dimensions (in Inches): Outside Dimensions: 47 x 26; Inner Dimensions: 39 (Top), 20 (Bottom), 12 (Height); Outside Base Dimensions: 21.5 x 21.5.
- D. Weight: 535 pounds
- E. Cast Stone Planter Urn shall be placed on a solid level surface and not directly on grass, soil, or an uneven surface. Ensure proper drainage by 1.) Placing a layer of coarse gravel or other appropriate drainage material in the bottom of the container, and 2.) Making sure the drainage holes are not blocked. If the planter remains in contact with the ground surface over the winter, the freeze-thaw cycles may cause the planter to crack or crumble.

PART - 3 EXECUTION

3.1 PRE-INSTALLATION EXAMINATION

- A. The installer shall examine previous work, related work, and conditions under which this work is to be performed and notify the Contractor in writing of all

deficiencies and conditions detrimental to the proper completion of this work. Beginning work means installer accepts substrates, subgrades, previous work, and conditions.

3.2 CAST STONE PLANTER URN

- A. Review layout of Cast Stone Planer Urn with the Landscape Architect prior to installation.
- B. Install Cast Stone Planer Urn true and plumb to the lines and dimensions shown on the Drawings.
- C. Install Cast Stone Planer Urn according to manufacturer's recommendations.

END OF SECTION

SECTION 328424

BEDROCK WELL INSTALLATION

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- A. Bedrock Well Installation Work shall be priced as part of Add Alternate #3 in the overall project.
- B. Coordinate work with other underground utilities and trades responsible for installation.
- C. Fill out Bid Sheet attached at end of SPECIFICATIONS for unit pricing on materials, labor and total bid price.

1.2 DEFINITIONS

- A. SITE
 - 1. Larz Anderson Park Lagoon, Brookline, MA
- B. OWNER
 - 1. Town of Brookline, MA
- C. OWNER'S REPRESENTATIVE
 - 1. Klopfer Martin Design Group, Boston, MA
- D. ENGINEER
 - 1. Aqueous Consultants, LLC, Andover, MA
- E. CONTRACTOR
 - 1. Entity awarded to perform the work specified in this section
- F. SPECIFICATIONS
 - 1. Construction, testing, and reporting SPECIFICATIONS within this document

1.3 BID WORK

- A. Work to be done includes furnishing all labor, materials, equipment, and services (development and testing) required for construction of one (1) 6-inch bedrock irrigation well.
- B. Well location shall be located by OWNER and OWNER'S REPRESENTATIVE.
- C. Access to SITE shall be reviewed prior to bid submission and coordinated with OWNER'S REPRESENTATIVE.
- D. Irrigation well construction consists of:
 - 1. Overburden drilling operation
 - 2. Installing the well casing through overburden and sealed 20 feet into bedrock
 - 3. Bedrock drilling operation

4. Hydrofracturing to maximize aquifer openings
 5. Testing for yield, drawdown, and water quality
 6. Protecting aquifer quality
- E. Target yield in gallons per minute (gpm) for the proposed well shall be 20 - 40 gpm. Test and develop well for maximum possible sustainable flow.
- F. Assumed Bedrock Drilling Depth = 400 feet
1. Cost for Additional Drilling shall be paid to CONTRACTOR on a "per foot" basis. CONTRACTOR shall include with bid price unit cost for 6-inch additional drilling in bedrock per foot.
 2. Target yields developed in less than 400 feet shall result in CONTRACTOR credit to OWNER for feet not drilled based on unit cost provided.
 3. Alternative Drilling locations at SITE shall be considered and approved by OWNER or OWNER'S REPRESENTATIVE prior to drilling.
- G. All materials permanently installed shall be new, without flaws or defects, and meet requirements of SPECIFICATIONS.
- H. All material overages at installation completion are property of CONTRACTOR and shall be removed from SITE.
- I. Work shall be constructed and finished in every respect in an efficient and substantial manner, to the full intent and meaning of the SPECIFICATIONS. All parts necessary for the proper and complete execution of the work whether the same may have been specifically mentioned or not, shall be done or furnished in a manner corresponding with the rest of the work as if the same were specifically herein described.
- 1.4 EXCLUSIONS AND CONDITIONS
- A. Installation items are not included with SPECIFICATIONS:
1. Permanent pump and drop pipe installation
 2. Permanent power units
 3. Well pump control panels
 4. Irrigation system and connections
- B. CONTRACTOR is responsible for providing the following equipment to install and test wells:
1. Portable power supply
 2. Temporary submersible pump and motor for testing
 3. Valves and gauges
 4. Metering equipment
- 1.5 ORDINANCES, PERMITS, CERTIFICATIONS, AND INSPECTIONS
- A. Work described herein shall comply with all ordinances and regulations of authorities having jurisdiction. This shall include all applicable local, state, and federal regulations.

- B. Obtain and pay for any and all additional local and state permits (Board of Health, etc.), tests, and certifications required for the execution of work under this section.
- C. Furnish copies of permits, certifications, and approval notices to OWNER'S REPRESENTATIVE prior to requesting final payment.

1.6 EXAMINATION OF SITE

- A. CONTRACTOR shall fully inform themselves of SITE existing conditions before submitting bid in order to complete BID WORK.
- B. No claim for extra compensation or extension of time will be allowed on account of actual conditions inconsistent with those assumed.
- C. For bidding purposes:
 - 1. 10-Inch drilling depth through overburden estimated to be 50 feet
 - a. Log Overburden Soil Material from 0 – 20 feet below ground surface (BGS) every 5 feet.
 - 2. 10-Inch drilling depth through bedrock for sealed well casing shall be 20 feet
 - 3. 6-inch sealed well casing shall be installed a total length of 70 feet
 - 4. Bedrock well depth below well casing shall be 330 feet (400 feet total).
- D. Based on existing SITE knowledge and limited access, proposed irrigation well location is assumed to be acceptable for drilling.
- E. CONTRACTOR shall drill production well in approximate locations as coordinated with ENGINEER and OWNER'S REPRESENTATIVE.
- F. Access to land immediately surrounding the well drilling location will be granted with sufficient working space for drilling and developing operations.
- G. CONTRACTOR shall coordinate with the OWNER'S REPRESENTATIVE and ENGINEER to inform and be informed of any hazards or obstructions which may affect the location(s) of the production well(s), 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
- H. Contact DIG-SAFE/811 at least 72 hours prior to drilling, or as required by law. Mark out entrance to SITE along street for DIG-SAFE employees.
- I. Avoid local depressions and low points that collect or convey surface runoff.

1.7 QUALITY ASSURANCE

- A. Installer

1. Firm that has minimum (5) years of experience similar work and projects as described in SPECIFICATIONS
2. Persons supervising and constructing proposed BID WORK shall be personally experienced in well construction and shall have been regularly employed by a company engaged in well construction for a minimum of three (3) years.
3. Furnish to the ENGINEER the names and addresses of three (3) similar projects with the persons or entities installing and testing wells over the past three (3) years (see Bid Sheet).
4. Qualifications shall be approved by OWNER and OWNER'S REPRESENTATIVE.

B. Well Disinfection and Aquifer Protection

1. Conform to provisions of AWWA Standards A-100 and C-654 except where modified herein.
2. Maintain a copy of these standards at all times at SITE.

C. Applicable requirements of accepted Standards and Codes shall apply to the Work of this Specification:

1. American Society for Testing & Materials (ASTM)
2. National Plumbing Code (NPC)
3. National Electric Code (NEC)
4. National Sanitary Foundation (NSF)
5. American Water Works Association (AWWA)
6. American Society of Agricultural and Biological Engineers (ASABE)
7. National Groundwater Association (NGWA)

1.8 BONDS AND INSURANCE

- A. Coordinate with OWNER'S REPRESENTATIVE for Insurance Requirements.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store and handle all materials in compliance with manufacturer's instructions and recommendations.
- B. Protect materials from all possible damage
- C. Coordinate with OWNER'S REPRESENTATIVE for SITE storage of materials and construction equipment.

1.10 GUARANTEE

- A. CONTRACTOR shall obtain in OWNER'S name standard written manufacturer guarantees of all permanently installed materials furnished where such guarantees are offered in published product data.
- B. All manufacturer guarantees shall be in addition to, and not in lieu of, other liabilities CONTRACTOR may have by law.
- C. Problems developed within warranty period due to faulty materials or workmanship shall be corrected to ENGINEER'S satisfaction at no additional expense to OWNER.

- D. Provide a written warranty to OWNER showing date of completion and period of warranty upon completion of the project.

1.11 COORDINATION

- A. CONTRACTOR should at all times coordinate BID WORK closely with ENGINEER and OWNER'S REPRESENTATIVE to avoid misunderstandings and to efficiently bring the project to completion.
- B. CONTRACTOR shall also coordinate BID WORK with any approved subcontractors and other trades working at SITE.
- C. CONTRACTOR shall be held responsible for and shall pay for all damage to other work caused by BID WORK, CONTRACTOR employees or subcontractors. Repairing of such damage shall be done by entity installing the damaged items, as directed by OWNER'S REPRESENTATIVE.

1.12 INSTALLATION SUBMITTALS

- A. CONTRACTOR shall provide three (3) copies on all proposed equipment to be installed to OWNER'S REPRESENTATIVE for approval by ENGINEER.
- B. No well construction or drilling operation shall commence until all product sheets are received and approved.
- C. Product data shall contain size, manufacturer, weight, description of items outlined in SPECIFICATIONS.
- D. Equipment to be submitted, but not limited to, includes:
 - 1. Well Casing(s)
 - 2. Sanitary Well Seal(s)
 - 3. Grout Seal
 - 4. Miscellaneous Materials

1.13 AS-BUILT SUBMITTALS

- A. Upon completion of work and prior to application for acceptance and final payment, a minimum of two (2) three-ring binders titled IRRIGATION WELL AS-BUILT DATA FOR LARZ ANDERSON PARK LAGOON shall be submitted to the OWNER'S REPRESENTATIVE for approval which includes:
 - 1. Well Installation Logs (including Overburden Logs from 0' – 50' BGS)
 - 2. Yield Test Data (as specified herein)
 - 3. Approved Submittals for all products used in well construction
 - 4. Manufacturers' guarantees (if applicable)
- B. As-Built Report Binders shall be completed and submitted within seven (7) days of the final well installation. Other trades and SPECIFICATIONS require this final data to begin additional phases of this project.

1.14 INSTRUCTIONS TO BIDDERS

- A. All bids must be made on the provided bid form. All blank spaces for bid prices must be filled in, in ink or typewritten, and the bid form must be complete and executed when submitted.

PART 2 – PRODUCTS

2.1 GENERAL

- A. Use only new materials conforming to the standard(s) applicable to each type, as specified and approved by the ENGINEER. Provide listed manufacturer's products specified, unless approved equals are specified.
- B. For warranty purposes, equipment shall be supplied from authorized distributors of the various products.

2.2 WELL CASING(S)

- A. Well casing(s) shall be Schedule 40 seamless steel pipe rated for well casing as per AWWA standards.
- B. Casing(s) shall be nominally 6-inch in diameter with minimum thickness of ¼-inch.
- C. Steel pipe shall conform to ASTM A-53, A-106, A-120, and API-5L as manufactured by U.S. Steel, U.S. Pipe, Victory Steel or approved equal.

2.3 SANITARY WELL SEAL(S)

- A. Sanitary well seal(s) shall be installed at the top of the well(s). Well seal(s) shall utilize two 3/16-inch stainless steel plates with a 3/4-inch expansion seal.
- B. Well seal(s) shall have a hole for the pump(s) pull pipe and one for the electrical wiring(s).
- C. Sanitary seal shall be minimum 6 inches (nominal to match well casing).

2.4 CASING SEALS

- A. Casing seals shall be 2 inches thick minimum around outside of entire length of well casing (from ground surface to 20 feet into bedrock).
- B. Casing seals used shall be of environmental standard so as to not introduce contaminants to surrounding aquifer.
- C. Casing seal shall be made of cement grout, bentonite, or concrete.

PART 3 – EXECUTION

3.1 GENERAL

- A. Examine all contract documents applying to this Specification noting any discrepancies and bringing same to the attention of the ENGINEER for timely resolution.
- B. Make all field measurements necessary for the work noting the relationship of the well work to the other trades (coordinate with OWNER'S REPRESENTATIVE).
- C. At all times, protect existing landscaping, paving, structures, walls, footings, etc. from damage. Any inadvertent damage to the work of another trade shall be reported at once.
- D. All well(s) yield testing(s) shall be in strict accordance of this Specification.
- E. Well(s) construction, well(s) development, well(s) testing, and test well(s) abandonment shall be in strict accordance with ASABE EP 400.2T JAN 1994 (R2005) "Design and Constructing Irrigation Wells".
- F. All equipment and materials shall be placed in the well(s) in a manner, which meets design SPECIFICATIONS, unless some good and sufficient reason is encountered during construction to deviate from design SPECIFICATIONS. CONTRACTOR, ENGINEER, and OWNER'S REPRESENTATIVE shall mutually agree upon changes. Written records shall be maintained.

3.2 WELL CONSTRUCTION AND DEVELOPMENT

- A. Borehole
 - 1. Borehole shall be round, plumb, straight, and of adequate diameter to permit satisfactory and proper installation of the well casing and future well pump.
- B. Casing
 - 1. Well casing shall be plumb and straight such that it shall not deviate from vertical by more than half the casing diameter per 100 feet.
 - 2. Casing shall be sealed from surface to 20 feet into bedrock.
 - 3. Well casing shall be cut off a minimum of 12 inches above finish grade but no more than 24 inches.
 - 4. A circular hole through the well casing, 2 inches in nominal diameter, shall be provided five (5) feet below the finish grade elevation for the purpose of connecting irrigation mainline to well discharge through pitless adapter.
- C. Well Development
 - 1. Development of bedrock wells shall remove chips, slurry fluid, and drilling debris from fractures, thereby opening passages for water to enter the well more freely.
 - 2. Well development shall be performed before yield test.
 - 3. Well shall be sufficiently developed via surging, pumping, water or air jetting, or other industry standard.
 - 4. Notify ENGINEER and OWNER'S REPRESENTATIVE after well construction and development is complete prior to yield testing.

- D. Aquifer Protection
 - 1. Well bore and drilling equipment shall be disinfected with a chlorine solution to destroy any bacteria introduced during the construction and development processes.
 - 2. Chlorine solution shall have a minimum of 100 mg/L (100 ppm) available chlorine in solution when mixed with the volume of water in the well bore. The well shall then be properly capped for protection.
 - 3. Formation seal shall be provided around the well casing made of cement grout, bentonite, or concrete.
 - 4. Formation seal placed in an annular space shall prevent the seepage of contaminated surface water down along the outside of the casing into the well (approximately 2 inches thick).
 - 5. Sealing shall extend approximately twenty (20) feet into bedrock.
 - 6. Finished land surface shall be graded to direct runoff water away from well.

- E. Construction Certification
 - 1. Certification that the well was constructed in such a manner as to satisfy all original design SPECIFICATIONS shall be given unless the SPECIFICATIONS were modified in writing by prior and mutual agreement. Any modifications of original SPECIFICATIONS shall be included in certification.
 - 2. Certification shall include a full construction log detailing well depth, fracture locations, development method, and GPS coordinates (latitude and longitude). Fill out DCR Well Completion Form legibly and in entirety.

3.3 YIELD AND DRAWDOWN TESTING

- A. Each well shall have three (3) phases of mandatory testing:
 - 1. Step drawdown test
 - 2. Pumping yield test
 - 3. Recovery test

- B. Prior to commencement of testing, ensure that pump discharge is directed away from the recharge zone surrounding the well (coordinate with OWNER'S REPRESENTATIVE or local permitting agencies).

- C. Step Drawdown Test (4.5 Hours)
 - 1. Set temporary submersible pump within bedrock well
 - 2. Record static water level
 - 3. Begin pumping at 50% of required yield (15 gpm)
 - 4. Record drawdown at the following intervals:
 - a. Every minute for the first 10 minutes after pumping starts
 - b. Once every 10 minutes from 10 minutes to 90 minutes
 - 5. Increase pumping rate to 100% of required yield (30 gpm)
 - 6. Record drawdown at the following intervals:
 - a. Every minute for the first 10 minutes after pumping starts
 - b. Once every 10 minutes from 10 minutes to 90 minutes
 - 7. Increase pumping rate to 150% of required yield (45 gpm)
 - 8. Record drawdown at the following intervals:
 - a. Every minute for the first 10 minutes after pumping starts
 - b. Once every 10 minutes from 10 minutes to 90 minutes
 - 9. Stop step drawdown test and allow well to recover to steady-state condition.
 - 10. Record time to recovery.

- D. Yield Test (24 Hours)
 - 1. Set temporary submersible pump within bedrock well

2. Record static water level
3. Begin pumping at 100% of possible yield (30 gpm)
4. Record drawdown at the following intervals:
 - a. Every minute for the first 10 minutes after pumping starts
 - b. Once every 10 minutes from 10 minutes to 120 minutes
 - c. Once every 30 minutes from 120 minutes to 1440 minutes
5. If yield test is stopped for more than 15 minutes, the test must be abandoned and started from the beginning allowing well to recover—COST OF TIME AND MATERIALS TO RESET TEST SHALL BE AT CONTRACTOR'S EXPENSE.

E. Recovery Test (4 hours)

1. At the conclusion of the yield test, immediately begin recording well recovery depths from the time the pump is shut off.
2. The time for the recovery test is 4 hours (240 minutes) OR when 95% of the well has recovered, whichever is shorter.
3. Record recovered water levels at the following intervals:
 - a. Every minute for the first 10 minutes after pumping stops
 - b. Once every 10 minutes from 10 minutes to 120 minutes (or until 95% recovery)
 - c. Once every 30 minutes until 95% recovery is reached

F. Data Reports

1. Present drawdown and recovery data in legible (typed notes preferred) report with time and flow rates reported in corresponding columns.

3.4 WATER QUALITY TEST

- A. Immediately upon completion of the yield testing, CONTRACTOR shall take water sample for physical, chemical, and bacteriological analysis. Sample shall be taken in the presence of the OWNER'S REPRESENTATIVE.
- B. CONTRACTOR shall make all necessary arrangements and promptly send samples either to a local Health Department laboratory or to a private laboratory that is approved by the local Health Department.
- C. Water quality analysis shall be conducted in accordance with standards and methods approved by the local and State Health Departments, as well as the United States Environmental Protection Agency. Analysis shall include testing for following:
 1. Arsenic
 2. Boron
 3. Beryllium
 4. Cadmium
 5. Calcium
 6. Chromium
 7. Copper
 8. Iron
 9. Lead
 10. Magnesium
 11. Manganese
 12. Mercury
 13. Potassium
 14. Sodium
 15. Selenium
 16. Zinc

17. Chloride
18. Sulfate
19. Nitrate
20. Nitrite
21. Turbidity
22. Total Coliform Bacteria
23. pH
24. Hardness
25. Alkalinity (all forms)
26. Carbonate
27. Bicarbonate
28. Total Dissolved Solids
29. Electrical Conductivity

3.5 ACCEPTANCE AND OPERATION

- A. Upon completion of the work and acceptance by the ENGINEER and OWNER'S REPRESENTATIVE, the CONTRACTOR shall be responsible for providing all specified information in the as-built binder.
- B. As described above, CONTRACTOR shall guarantee all parts and labor for a minimum period of one (1) year from the date of acceptance.

3.6 CLEAN UP

- A. Upon completion of all installation work, CONTRACTOR shall remove all leftover materials and equipment from SITE in a safe and legal manner.
- B. CONTRACTOR shall leave SITE clean and free of all debris generated from installation of irrigation well.

END OF SECTION

BID SHEET TO CONSTRUCT BEDROCK WELLS (UNIT PRICING SHEET)

The following unit prices, to be filled out by all bidders, shall be used for additions or deletions to the irrigation well construction due to actual site conditions. Prices shall include said material and installation labor as well as necessary equipment costs complete in place, along with any applicable taxes, supervision, and delivery charges.

BID SHEET TO CONSTRUCT AND TEST BEDROCK WELL

The following unit prices, to be filled out by all bidders, shall be used for additions or deletions to the irrigation well construction due to actual site conditions. Prices shall include said material and installation labor as well as necessary equipment costs complete in place, along with any applicable taxes, supervision, and delivery charges.

Item No.	Item Description	Item Qty.	Item Units	Fill-In Unit Price	Balance for Total Price
1	Pre-Construction Meeting with Owner's Representative and Engineer	1	Meeting		
2	Laboratory Water Quality Analysis and Report for Sample Collected from Bedrock Well	1	Lab Analysis		
3	10-Inch Drilling in Overburden for 6-Inch Irrigation Bedrock Well Casing	50	feet		
4	10-Inch Drilling in Bedrock for 6-Inch Irrigation Bedrock Well Casing	20	feet		
5	6-Inch Steel Well Casing for Irrigation Bedrock Well	70	feet		
6	2-Inch Annular Grout Seal around Well Casing for Aquifer and Well Protection	70	feet		
7	6-Inch Bedrock Drilling (below casing) for Irrigation Bedrock Well (400 feet total)	330	feet		
8	Development and Fracture Opening for Irrigation Bedrock Well	1	well		
9	Well Testing and Recording with Temporary Test Pumps (Step-Drawdown, Yield, Recovery)	32	hours		
	Other Products Required for Well Installation				
10	Pitless Adapter Unit (2-Inch Outlet)	1	adapter		
	Sanitary Well Seal	1	well seal		
	Well Cap	1	cap		
Total 6-Inch Bedrock Well Drilling & Testing Bid Price					

(next, please)

BID SHEET TO CONSTRUCT IRRIGATION WELLS (TOTAL BID PRICE SHEET)

TOTAL BID PRICE FOR ITEMS 1 – 10 ABOVE: \$

TOTAL BID PRICE WRITTEN IN WORDS:

CONTRACTOR NAME

CONTRACTOR ADDRESS

CONTRACTOR PHONE NUMBER

CONTRACTOR FAX NUMBER

CONTRACTOR SIGNATURE

SIGNATURE DATE

PRINTED NAME OF SIGNER

CONTRACTOR POSITION IN COMPANY

LIST OF PROJECTS AND REFERENCES:

SECTION 329200
TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and relevant sections of these Specifications, apply to the work specified in this Section.

1.2 SUMMARY

- A. Provide all labor, materials, equipment, services and accessories necessary to furnish and install the work of this Section, complete and functional, as indicated in the Contract Documents and as specified herein.
- B. The principal work of this Section includes, but may not be limited to, the following:
 - 1. Turf Seeding
 - 2. Turf Sodding
 - 3. Maintenance and Protection

1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surfaces.
- B. Turf or Lawn: An area covered with grass

1.4 SUBMITTALS

- A. At least 30 days prior to intended use, the Contractor shall provide the following samples and submittals for approval. Do not order materials until Landscape Architect approval of samples, certifications or test results has been obtained. Acceptance shall not constitute Final Acceptance. The Owner's Representative reserves the right to reject on or after delivery any material that does not meet these Specifications.
 - 1. Seed and Sod:
 - a. Submit a manufacturer's Certificate of Compliance to the Specifications with each shipment of each type of seed. These certificates shall include the guaranteed percentages of purity, weed content and germination of the seed, and also the net weight and date of shipment. No seed may be sown until the Contractor has submitted the certificates.
 - 2. Fertilizer:
 - a. Submit product literature of Seeding fertilizer and certificates showing composition and analysis.
 - b. Submit the purchasing receipt showing the total quantity purchased for the project prior to installation.

3. Seeding Schedule: Indicating anticipated planting dates for each type of seeding.
4. Hydroseeding:
 - a. Qualifications for hydroseeding installer
 - b. Certified statement for approval as to the number of pounds of materials to be used per 100 gallons of water.
5. Wood Cellulose Fiber Mulch: Submit one copy of manufacturer's literature
6. Erosion Control Mat
 - a. Submit one sample.

1.5 Quality Assurance

- A. Qualification of Landscape Contractor: The work of this Section shall be performed by a landscape contracting firm which has successfully installed work of a similar quality, schedule requirement, and construction detailing with a minimum of five years' experience. Submit proof that the Landscape Contracting firm meets this requirement.
- B. Qualification of Foreman or Crew Leader: All work of unloading, stockpiling, storing, transporting on-site, planting, fertilizing, and maintenance shall be supervised by a Foreman or Crew Leader who is a Certified Landscape Professional or a Certified Horticulturist. Submit proof of certification. Foreman and Crew Leader shall remain on the project on a consistent basis from the beginning of planting through provisional acceptance.

1.6 EXAMINATION OF CONDITIONS

- A. All areas to be improved shall be inspected by the Contractor before starting work and any defects such as incorrect grading, or drainage problems shall be reported to the Owner's Representative prior to beginning this work. The commencement of work by the Contractor shall indicate his acceptance of the areas to be improved, and he shall assume full responsibility for the work of this Section.
- B. The Contractor shall be solely responsible for judging the full extent of work requirements involved.

1.7 COORDINATION

- A. TURF MIX: The season for seeding Turf Mix shall be as follows:

Spring:	April 1 st to June 1 st
Fall:	August 15 th to September 15 th
- B. The actual construction work shall be done, however, only during periods within this season that are normal for such work as determined by weather conditions and by accepted practice in this locality. At his option, and on his own responsibility, the Contractor may proceed under unseasonable conditions without additional compensation, but subject to Owner's Representative's approval of time and methods.

PART 2 – PRODUCTS

2.1 SEED - GENERAL

- A. Seed shall be fresh, clean, new crop seed. Grass shall be of the previous year's crop and the weed seed content shall not exceed 1% by weight. The seed shall be furnished and delivered, in the proportion specified, in new, clean, sealed, and properly labeled containers. All seed shall comply with State and Federal seed laws. Submit manufacturer's Certificates of Compliance. Seed which has become wet, moldy or otherwise damaged shall not be acceptable. The Contractor shall take care to handle and store the seed according to grower's recommendations and shall not subject the seed to extremes of heat, cold or moist conditions. Submit seed mixtures to Owner's Representative for acceptance.
- B. Seed Species: Contractor shall submit weight by seed count for each seed mixture.

2.2 TURF MIX

- A. Turf Mix shall be adapted to both sun and shade conditions and northern climate. Mix shall consist of:

25% Confetti III Perennial Ryegrass
 20% Homerun GLSR Perennial Ryegrass
 20% Cardinal Creeping Red Fescue
 10% Longfellow II Chewing's Fescue
 10% Arrowhead Kentucky Bluegrass (Aggressive Type)
 10% Fahrenheit 90 Hybrid Bluegrass (TxKy Type)
 5% Blue Note Kentucky Bluegrass (Compact America Type)

- B. Turf Mix Application Rate: 5.0 lbs per 1,000 SF.

2.3 SOD

- A. Sod shall be nursery grown sod with the following seed mixtures and in accordance with percentages specified:
- B. Sod Mix shall be suitable for the following conditions:

Solar Requirements:	Sun or Shade
Irrigated:	Yes
Athletic Field:	Yes
Maintenance Level:	Low
Level of Use:	Maximum

- C. Seed mixture shall be composed of the following:

<u>Name</u>	<u>Composition % by Seed Species</u>	<u>Germination min.</u>	<u>Purity min.</u>
Award Kentucky Bluegrass	25%	85%	90%
Avalanche Kentucky Bluegrass	25%	85%	90%
America Kentucky Bluegrass	25 %	85%	90%
Hampton Kentucky Bluegrass	<u>25%</u>	85%	90%
	100%		

- D. Sod shall be from an established sod farm specializing in the production and harvesting of top quality, grass turf products. Sod shall be machine cut at a uniform soil thickness of 3/4-inch +/- 1/4 inch, at the time of cutting. Measurement for thickness shall exclude top growth and thatch. Individual pieces of sod shall be cut to the supplier's standard width and length. Maximum allowable deviation from standard widths and lengths shall be 5 percent. Broken pads and torn or uneven ends will not be acceptable. Sod shall be at least one year old from time of original seeding.
- E. Sod shall be free of grass species other than those specified in this Section. Sod shall be free of weeds.
- F. Sod shall be rolled or folded prior to handling. Sod shall be kept moist during transit and installed on site not more than forty-eight (48) hours after cutting.
- G. Stakes for pegging the sod shall be sound hardwood approximately one inch by 2 inches and of sufficient length to penetrate the mat, the seed bed and to a minimum depth of 2 inches of subsoil. Stakes shall be free from insects and fungi and capable of remaining in the ground at least 2 years.
- H. Sod delivered to the construction site which does not conform to the requirements of this Section will be rejected by the Owner's Representative and shall be removed from the site by the Contractor at no additional cost to the Owner. Sod found to contain unacceptable levels of unspecified grass species or weed species at any time up to and including Final Acceptance will be rejected by the Landscape Architect. Contractor shall remove such sod from the site at no additional cost to the Owner. Contractor shall replace unacceptable sod with new, approved sod at no additional cost to the Owner.

2.4 FERTILIZER

- A. Fertilizer shall be a commercial product complying with the State and Federal fertilizer laws. Deliver to the site in the original unopened containers that shall bear the manufacturer's certificate of compliance covering analysis. Fertilizer shall contain not less than the percentages of weight of ingredients recommended by the Soil Analysis.
- B. Nitrogen fertilizer shall be slowly soluble ureaformaldehyde, methylene urea, or isobutylidenediurea; or slow release sulfur-coated urea.
- C. Phosphorus shall be superphosphate or treble superphosphate.
- D. Potassium shall be sulfate of potash, K_2SO_4 .
- E. Salt indexes per unit of nutrient for nitrogen, phosphorous, and potassium shall be less than 1.0 when compared to sodium nitrate (6.3).

2.5 HERBICIDE, CHEMICALS AND INSECTICIDE

- A. No chemicals or insecticides shall be used for fungus or pest control. If such controls are needed an organic or natural alternative should be discussed with Owner.

2.6 WATER

- A. The Contractor shall be responsible for furnishing his/her own supply of water to the site at no extra cost. All plant materials or beds injured or damaged due to the lack of water, or the use of too much water, shall be the Contractor's responsibility to correct. Water shall be potable.

- B. Contractor shall not assume that any existing irrigation system on site will be available or in working order.
- C. Contractor shall obtain any necessary permits and written approvals from the client to use a municipal water source to water the plant material.
- D. Provide water schedule upon completion of planting. Should Contractor deviate from the schedule, he/she shall notify the Owner's Representative 24 hours prior to watering plant material.

2.12 EROSION CONTROL MAT

- A. Matting for erosion control shall consist of undyed and unbleached smolder resistant jute yarn woven into a uniform, open, plain weave mesh. Jute matting shall be furnished in rolled strips and shall conform to the following:
 - 1. Width: 48 inches, plus or minus one inch 78 warp ends per width of cloth 41 weft ends per yard
 - 2. Weight: To average between 1.22 pounds and 1.80 pounds per linear yard: tolerance plus or minus 5%
 - 3. Erosion Control Mat shall be Geocoir 700 as manufactured by Belton Industries, or approved equal.
- B. Stakes for pegging erosion control matting shall be sound hardwood approximately one inch (1") by three inches (3") by 10 inches (10"). Stakes shall be free from insects and fungi and capable of remaining in the ground at least two (2) years.

2.7 WOOD CELLULOSE FIBER MULCH

- A. Mulch to cover hydroseeded and hand seeded areas shall be fiber processed from whole wood chips and clean recycled newsprint in a 1:1 proportion manufactured specifically for standard hydraulic mulching equipment. Fiber shall not be produced from recycled material such as sawdust, paper, or cardboard.
- B. Moisture content shall not exceed 12 percent, plus or minus 3 percent as defined by the pulp and paper industry standards. Fiber shall have a water holding capacity of not less than 900 grams water per 100 grams fiber.
- C. The mulch shall be of such character that the fiber will be dispersed into uniform slurry when mixed with water. It shall be nontoxic to plant life or animal life.
- D. The mulch shall contain a non-petroleum based organic tackifier and a green dye to allow for easy visual metering during application but shall be non-injurious to plant growth.
- E. The mulch shall be International Paper Company's "Turfiber", Weyerhaeuser Company's "Silva-Fiber", or approved equal and clearly packed in original containers, sealed and clearly labeled with brand name and manufacturer.

PART 3 – EXECUTION

3.1 FILLING AND COMPACTION

- A. Filling and compaction of loam shall be specified and performed under the work of the Section, EARTHWORK, of this Specification.

3.2 FINE GRADING

- A. Fine grading shall be specified and performed under the work of the Section, EARTHWORK, of this Specification.
 - 1. Contractor shall request and receive a letter from the Owner's Representative stating that all fine grading has been accepted before doing any seeding.
 - 2. Seeded areas shall be installed immediately after finish grading has been completed.

3.3 EXAMINATION

- A. Examine areas to receive lawns for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 GENERAL PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other objects.
 - 4. Protect adjacent and adjoining areas from hydroseeding overspray.
- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.5 HYDROSEEDING

- A. Prior to the start of work, furnish a certified statement as to the number of pounds of materials to be used per 100 gallons of water. This statement shall also specify the number of square feet of hydroseeding that can be covered with the quantity of solution in the hydroseeder.
- B. For the hydroseeding process, a mobile tank with a capacity of at least 500 gallons shall be filled with water and the mixture noted above in the specified proportions. The resulting slurry shall be thoroughly mixed by means of positive agitation in the tank. At no time shall the mobile tank or tank truck be allowed onto the prepared hydroseed beds. Only hose application shall be permitted. The hose shall be equipped with a nozzle of a proper design to ensure even distribution of the hydroseeding slurry over the area to be hydroseeded and shall be operated by a person thoroughly familiar with this type of seeding operation.
- C. Hydroseeding shall be a multi-step process.
 - 1. Step one shall consist of spreading 100 percent of the required seed uniformly over the prepared loam bed so that the seed comes into direct contact with the soil. This method shall only be used in the Turf seeding areas
 - 2. Step two shall consist of a separate application of wood cellulose fiber mulch immediately following the first step of hydroseeding noted above. This step shall also be used over areas where meadow and turf seed has been hand seeded. Apply the wood cellulose fiber mulch at a rate of 1,700 pounds per acre. (Total wood cellulose fiber mulch cover shall be 2000 lbs. per acre.)

3.6 CLEANUP AND PROTECTION

- A. Absolutely no debris may be left on the site. Excavated material shall be removed as directed. Repair any damage to site or structures to restore them to their original condition, as directed by the Owner's Representative, at no cost to the Owner.
- B. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- C. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.

3.7 MAINTENANCE OF SEEDED AREAS

- A. Begin maintenance immediately after each area is seeded or sodded for the following time period:
 - 1. A 90 day active growing period or until Final Acceptance, whichever is longer.
- B. Maintenance shall include re-seeding or re-sodding, mowing, watering, weeding, and fertilizing as specified, and re-setting and straightening of protective barriers. Lawn work maintenance shall also include treatments as required for fungus, weed and/or pest control.
- C. During the maintenance period, any decline in the condition of seeded or sodded areas shall require immediate action to identify potential problems and to undertake corrective measures.
- D. Watering shall be done in a manner that will provide uniform coverage, prevent erosion due to application of excessive quantities over small areas, and prevent damage to the finished surface by the watering equipment.
 - 1. The Contractor shall provide all labor and arrange for all watering necessary to establish an acceptable lawn or meadow. In the absence of adequate rainfall, watering shall be performed daily or as often as necessary to maintain moist soil to a depth of at least 2 inches for seeded areas and 4 inches for sodded areas. At no time shall a tank truck be allowed on the seeded and/or sodded surface.
 - 2. The Contractor shall furnish sufficient watering equipment to apply water to the required soil depths each 8-hour period.
- E. Protection
 - 1. Seeded areas shall be protected by a 6-foot high standard chain link barrier set at 10 foot intervals and connected by No.10 wire. Flags of white cloth shall be secured to the wire at center points between stakes.
 - 2. Barriers must be raised immediately after lawn construction and shall be maintained until Acceptance. Barriers shall be removed and discarded as directed by the Owner's Representative.
- F. Establishment:
 - 1. All seed and sod shall become established. Dead portions of seeded or sodded area shall be removed and replaced. All joints between sod pieces shall be filled with loam. All pieces of sod shall have knit to loam

sodded areas are deficient, the Contractor's responsibility for maintenance of all seeded and sodded areas shall be extended until deficiencies are corrected. Areas to be corrected shall be prepared and re-seeded or sodded in accordance with the requirements of this Section.

2. At the time of acceptance, the Contractor shall remove temporary barriers used to protect lawn areas.
- C. Furnish full and complete written instructions for maintenance of the lawns to the Owner at the time of acceptance in conformance with Submittals requirements.
- D. Owner's Representative's inspection shall determine whether maintenance shall continue.

END OF SECTION