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APPENDICES

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SECTION 01 23 00 - ALTERNATES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for alternates.

1.2 REFERENCE

A. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.

1.3 DEFINITIONS

A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to or deducted from the Base Bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

1. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.4 RELATED WORK

A. Section 31 00 00 - Earthwork
B. Section 32 90 00 - Lawns and Planting

1.5 PROCEDURES

A. Coordination: Modify or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.

1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.

B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to alternates.

C. Execute accepted alternates under the same conditions as other work of the Contract.

D. Schedule: A Schedule of Alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. ALTERNATE NO. 1: SODDED LAWN

State the amount to be ADDED to the base bid for installing new sodded lawn as specified in Section 32 90 00, LAWNS AND PLANTING, in this Specification in lieu of seeded lawn as necessary for a complete installation.

END OF SECTION

SECTION 01 57 13 - TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 – GENERAL

1.1 REFERENCE

A. The conditions and general requirements of the Contract, Divisions 0 and 1 apply to the work under this Section.

1.2 SCOPE OF WORK

A. The work of this Section shall consist of providing all labor equipment, materials, incidental work, and construction methods necessary to provide and install erosion and sediment control, and related items as indicated on the Contract Documents and/or specified herein and includes but is not limited to the following:

1. Sediment Filter Barrier System

1.3 REFERENCES

A. The following standards shall apply to the work of this Section.

1. MassDOT: Commonwealth of Massachusetts Department of Transportation, "Standard Specifications for Highways and Bridges" (MassDOT Specifications), latest edition.

B. The following standards are applicable to the work of this Section to the extent referenced herein:

1. Massachusetts Erosion and Sedimentation Control Guidelines for Urban and Suburban Areas, A Guide for Planners, Designers and Municipal Officials”, prepared by the Massachusetts Dept. of Environmental Protection, Bureau of Resource Protection, dated March 1997, reprinted May 2003.

1.4 SATISFACTORY PERFORMANCE

A. Soil erosion control measures shall at all times be satisfactory to the Owner’s Representative. When it becomes necessary, the Owner’s Representative shall inform the Contractor of an unsatisfactory construction status, procedures and/or operations. If the unsatisfactory construction status, procedures, and/or operations are not promptly corrected, the Owner’s Representative may suspend the performance of any and all construction until the unsatisfactory condition has been corrected, and such suspension shall not be the basis of any claim by the Contractor for additional compensation from the Owner nor for an extension of time to complete the work.

1.5 SUBMITTALS

A. Submittals shall include:

1. List of proposed materials including manufacturer's product data.
2. Schedule of erosion control programs indicating specific dates for implementing programs in each major area of work.

1.6 PERMITS, CODES, AND REGULATIONS

A. Comply with all rules, regulations, laws and ordinances of the City and State, and all other authorities having jurisdiction over the Project site. All labor, materials, equipment, and services necessary to make the work comply with such requirements shall be provided by the Contractor without additional cost to the Owner.

B. Comply with the most stringent provisions of all applicable regulations of the Commonwealth of Massachusetts; Department of Environmental Protection (DEP); the Army Corps of Engineers (ACOE); and the United States Environmental Protection Agency (EPA).

1.7 DESCRIPTION OF EROSION CONTROL WORK

A. Control measures to prevent all erosion, siltation and sedimentation shall occur in areas of construction within limit of work, adjacent areas and off-site areas outside the limit of work.

1. Control measures shall be accomplished adjacent to or in the following work areas:
   a. Soil stockpiles and on-site storage and staging areas.
   b. Cut and fill slopes and other stripped and graded areas.
   c. At existing drainage structures.

2. The Contractor shall install all measures as needed to control sediment and erosion as required by the Contractor's construction methods and operations, the weather conditions, and as directed by the Owner's Representative.

3. Additional means of protection shall be provided by the Contractor as required for continued or unforeseen erosion problems, at no additional cost to the Owner.

4. Periodic maintenance of all sediment control structures shall be provided to ensure intended purpose is accomplished. Sediment control measures shall be in working condition at the end of each day.

5. After any significant rainfall, sediment control structures shall be inspected for integrity. Any damaged device shall be corrected immediately.

6. Erosion control measures shall be established at the beginning of construction and maintained during the entire period of construction. On-site areas which are subject to severe erosion, and off-site areas which are especially vulnerable to damage from erosion and/or sedimentation, are to be identified and receive special attention.

7. It shall be the responsibility of the Contractor to render the site erosion free. Approval by Owner's Representative of any method to accomplish this does not relieve the Contractor of full responsibility for controlling erosion and/or sedimentation throughout the construction process.

8. Install filter barriers prior to any site clearing, removals or general earthwork and maintain in place in good functioning condition until all work is complete or as otherwise directed by the Owner's Representative. Repair as required.

9. All land-disturbing activities are to be planned and conducted so as to minimize off-site sedimentation damage.

10. The Contractor is responsible for cleaning out and disposing of all sediment once the storage capacity of the sediment facility is reduced by one-half.

11. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

PART 2 - PRODUCTS

2.1 FILTER BARRIERS

A. Compost Filter Tubes shall be knitted mesh tubes filled with composted organic filter media and held into place with wood stakes. Tubes shall be 12-inch minimum diameter in 10 to 25-foot lengths.

1. Wood stakes shall be 2 inches x 2 inches (minimum) square cut, or 1-3/4" (minimum) diameter and shall be of sound quality hardwood.

B. Straw wattles shall consist of weed free rice straw inside biodegradable netting. Wattles shall be 9 inches in diameter in 10 to 25 foot lengths.

1. Stakes for wattles shall be one of the following materials:
   a. Wood stakes of sound hardwood, one inch by one inch (1" x 1") in size by 2' length min.
   b. Steel reinforcing bars of at least No. 4 size, by 2' length min.

2.2 SILTATION FENCE

A. Siltation fence shall consist of the following elements:

1. Fabric for siltation fence shall be a minimum width of 3 feet and conforming to the following criteria:

Fabric Properties	Value	Test Method
Grab Tensile Strength (lbs.)	100	ASTM D 4632
Elongation of Failure (%)	20	ASTM D 4632
Mullen Burst Strength (PSI)	200	ASTM D 3786
Puncture Strength (lbs.)	65	ASTM D 4833
Slurry Flow Rate (gal./min./s.f.)	10	ASTM D 4491
Apparent Opening Size (mm)	30	ASTM D 4751
Ultraviolet Radiation (stability %)	70	ASTM D 4355

2. Use only commercially available fabric that is certified in writing by the manufacturer for the purpose intended

3. Filter fabric shall be one of the following. Fencing other than that specified shall be subject to review and acceptance by the Owner's Representative.

Product	Manufacturer
Mirafi Envirofence	TC Mirafi
Propex Silt Stop	Amoco fabrics Corp.
FX-55	Carthage Mills

4. Siltation fence posts may be wood or metal. Wood post shall be a minimum of 1-1/4 in. by 1-1/4 in. by 5 ft. long hardwood stakes commonly used to support siltation fabric. Metal post shall be a minimum of 1 inch wide and 5 ft. long. Posts shall be spaced 8 ft. o.c. maximum.

5. Provide suitable heavy nylon cord for securing abutting silt fence posts.

2.3 CATCH BASIN FILTER

A. Catch basin filters shall be manufactured from a woven polypropylene geotextile and sewn by a double needle machine, using a high strength nylon thread. Seams have a certified average wide width strength per ASTM D-4884 of 165.0 lbs./in.

B. The filters will be manufactured to fit the opening of the existing catch basin or drop inlet.

C. Catch basin filter's geotextile fabric shall have the following properties:

Property (ASTM Test Method)	**Unit**	**Typical Values**
Grab Strength (D-4632-86)	lbs	300
Puncture (D-4632)	Lbs.	120
Grab Elongation (D-4632-86)	%	20(max)
Trapezoid Tear Strength (D-4533-85)	Lbs	120
Mullen Burst Strength (D-3786-80a)	Psi	800
Coeff. of Permeability (D-4491-85)	Cm/sec	0.55
Water Flow Rate (D-4491-85)	Gal/min/(ft)(ft)	40
Ultraviolet Stability (D-4355-84)	%	80

D. Use only commercially available sacks that are certified in writing by the manufacturer for the purpose intended.

E. Siltation Sacks shall be selected from one of the following. Siltation Sacks other than those specified shall be subject to review and acceptance by the Owner's Representative:

Product	Manufacturer
Siltsack	ACF Environmental, Inc VA
Stream Guard	FOSS Environmental
Dandy Bag	Dandy Products, Inc CO

1. The siltation sack shall be manufactured to fit the opening of the catch basin or drop inlet.
2. The sack shall have a colored cord approximately halfway up the sack to keep the sack away from the sides of the catch basin. This colored cord shall serve as a visual indicator by which the sack shall be emptied. Once the cord is covered with sediment, the sack shall be emptied, cleaned and placed back into the catch basin.
3. The sack will have the following features: two dump straps attached at the bottom to facilitate the emptying of the filters; the filters will also have lifting loops as an integral part of the system to be used to lift the filters from the basin.

PART 3 - EXECUTION

3.1 GENERAL

A. Control water born erosion and sedimentation on the construction site at all times. Utilize compost filter tubes between construction activities for all work where soil particles are exposed to water erosion.

B. Compost filter barriers, siltation fence and catch basin filters shall be installed prior to start of clearing and grubbing operations or any earthwork operations.

C. Installation Criteria:

1. Use compost filter tubes and straw wattles to intercept sheet flow only. Do not place where they will intercept concentrated flow.
2. Filter barriers clog and deteriorate rapidly: provide routine maintenance and replace when logs have become clogged.
3. Inspect frequently and after each rain event. Maintain filter barriers in place in good functioning condition until all work is complete or as otherwise directed by the Owner. Perform maintenance and repairs as necessary.
4. Install filter barrier as follows:
   a. Tubes shall be placed in a row on the contour with the ends of each log tightly overlapping the adjacent log.
   b. Each tube shall be laid directly onto the existing soil horizon. Scrape leaf litter away and the organic horizon away to expose bare soil and place sediment control log directly on bare soil. Rake organic materials back around the log.
   c. Tubes shall be securely anchored in place by either two stakes driven through the log into the ground. Place stakes no less than 10-feet on center.
5. All tubes shall be removed when the site has been stabilized. The trench where the logs were located shall be raked flush with the surrounding organic levels.
6. Remove sediment deposits prior to removing filter barrier.

3.2 CATCH BASIN FILTERS

A. Install catch basin filters prior to disturbance of soils uphill from inlet.

B. Catch basin filters shall be inspected after each rain event and at a minimum every two weeks.

C. Debris and silt shall be cleaned from filter on a regular basis.

END OF SECTION

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Not Used

SECTION 02 41 13 – SITE PREPARATION

PART 1 - GENERAL

1.1 REFERENCE

A. Attention is directed to the printed form of the Contract of the City of Worcester and Division 1 of which these specifications are hereby made a part.

1.2 SECTION INCLUDES

A. Work included: Provide labor, materials, and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Protection of existing metal picket fencing, concrete wall, bituminous concrete paving, cast-in-place concrete paving, utility poles and utilities to remain within and adjacent to the property.
2. Removal of existing stone dust surface, chain link fencing, concrete and brick pavers, benches, debris pile and flagpole.
3. Salvage and cleaning of existing metal picket gate, signs and granite monuments.
4. Installation of a 6’ height chain link construction fence with gate location determined by Owner’s Representative.
5. Sawcutting pavement.
6. Disposal of all debris legally off site.
7. Clearing and grubbing of existing pollinator vegetation.
8. Tree protection fencing.
9. Tree and stump removal.
10. Dust control.
11. Stripping existing lawn.
12. Protection of Existing Utilities.
13. Utility Demolition as required to accommodate new construction.
14. Protection and Abandonment of Utilities.
15. Disconnecting, capping, or sealing of utilities as required.

1.3 RELATED WORK

A. Section 01 57 13 - Temporary Erosion and Sedimentation Control
B. Section 04 00 00 - Masonry
C. Section 32 30 00 - Site Improvements

1.4 SUBMITTALS

A. The Contractor shall, prior to any removal of rubbish or debris from the site, submit written evidence satisfactory to the Owner’s Representative that he has an approved dumping location for debris and/or spoil from his demolition and excavation activities.

B. Prior to beginning the work of this Contract, the Contractor shall submit a plan indicating stockpile areas and equipment and materials storage areas to the Owner’s Representative for review and approval. The Contractor shall provide any security measures necessary to protect his work and equipment at no additional costs to the Owner.

1.5 EXAMINATION OF SITE AND DOCUMENTS

A. By submitting a bid, the Contractor affirms that he has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of lack of full knowledge of existing conditions.

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, as no additional compensation will be made for errors or inaccuracies that may be found therein.

1.6 LAWS AND ORDINANCES

A. Follow all Local, State and Federal laws and ordinances which apply to the work of this Section.

1.7 REFERENCES

A. MassDOT: "Standard Specifications for Highways and Bridges", Massachusetts Department of Transportation, Commonwealth of Massachusetts, latest edition.

B. Work operations shall meet American National Standards Institute [ANSI] Standard Z-133.1.

1.8 PUBLIC SAFETY

A. The Contractor shall be solely responsible for pedestrian and vehicular safety and control within the work site.

B. All equipment to be used and all work to be performed shall be in full compliance with all OSHA standards including, but not limited to, those regulations concerning noise levels, protective devices and operator safety. Immediately discontinue any obviously hazardous practice.

1.9 DIG SAFE

A. Contractor is required to contact Dig Safe (1-888-344-7233) a minimum of 3 business days prior to start of construction.

1.10 SPECIAL PROTECTION FOR MAINTAINING STREETS AND PUBLIC WAYS

A. Do not close or obstruct streets or sidewalks within the public right of way without a permit. Do not place or store material in streets or sidewalks.

B. Conduct operations with minimum interference to the abutting streets.

1.11 ACCESS TO JOB SITE

A. No access to the job site shall be allowed on or through the abutting private properties. Access to the job site shall be along the public rights of way.

PART 2 – PRODUCTS

2.1 MATERIALS

A. ROOT GROWTH ENHANCER: "Roots Solupaks” as manufactured by Lebanon Seaboard Corporation, 1600 E. Cumberland St., Lebanon, PA 17042, Roots, Inc., or approved equal.

B. CONSTRUCTION FENCE: Erect a 6' high galvanized chain link construction fence along the lines shown on the Drawings with gate locations to be determined in the field. Erect the fence immediately after receiving the Notice to Proceed and maintain the fence in a secure and sightly condition until instructed by the Owner's Representative to remove it or portions thereof. Secondhand fencing materials meeting the requirements specified herein and in good condition may be used to provide the necessary barrier during construction on this project. Equivalent tubular sections, H-sections or roll formed sections may be substituted for pipe sections if acceptable to the Owner's Representative. Gate location shall be approved by the Owner's Representative.

C. TREE PROTECTION FENCING: 6' chain link fence and posts as approved by Owner's Representative. Secondhand fencing materials meeting the requirements specified herein and in good condition may be used to provide the necessary barrier during construction on this project.

2.2 ARBORIST PERSONNEL

A. A crew shall consist of a minimum, one (1) tree trimmer/ climber, and one (1) ground person (one of which shall be a crew foreman and a Massachusetts Certified Arborist in good standing). The crew foreman shall have a minimum of five (5) years climbing and pruning experience.

PART 3 - EXECUTION

3.1 STAKING OUT PROJECT COMPONENTS

A. All lines and grades not presently established at the site shall be laid out by the Contractor in accordance with the Drawings. Maintain all established bounds and benchmarks and replace as directed any which are destroyed or disturbed.

B. Prior to starting any construction work, stake out all limits of proposed paving. Promptly upon completion of layout work and before any other construction work is begun on the site, notify the Owner's Representative, who shall conduct a field inspection of the stake-out.

3.2 TREE PROTECTION

A. Do not injure or deface vegetation to remain. Repair or replace any damaged items using a Certified Arborist approved by Owner's Representative. In the event that repair or replacement is not feasible, the Contract sum shall be reduced by the value of the damage based on the latest Standards approved by International Society of Arboriculture.

B. Do not use trees that are to remain for any purpose such as crane stays, guy anchors, etc. Do not place debris where damage to trees may result. Do not store materials, equipment or vehicles within drip line of trees to remain. Do not store materials on unpaved surfaces within drip line of trees to remain.

C. As approved by Owner's Representative, remove any roots and branches that would interfere with normal construction operations, or that need to be removed to balance the trees, without injury to trunks. Do any additional cutting or trimming only as necessary and in accordance with accepted standards of International Shade Tree Conference.

D. Do not damage roots of trees that are to remain during excavation. When excavating or trenching within the branch spread of trees scheduled to remain, do so in a manner which will cause minimum damage to root systems. Do not cut tree roots over 2 inches in diameter. Do not leave surface roots exposed. Neatly and cleanly saw cut roots that are necessary to remove as well as injured roots and backfill as soon as possible.

1. Notify Owner's Representative if any main root is encountered in the excavation. Obtain authorization prior to cutting and/or removal.
2. Temporarily cover exposed roots with wet burlap to prevent roots from drying out. Cover roots with earth as soon as possible.

3.3 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. The Contractor is responsible for coordinating and scheduling with the authorities having jurisdiction the removal and/or abandonment of existing utilities as required to complete the work.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner's representative 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's Representative not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without the Owner's Representative's written permission.

C. Utility pipes designated to be abandoned in place shall be plugged at their ends with watertight brick masonry or cement mortar with a minimum thickness of 8 inches.

D. Utility pipes designated to be removed shall consist of the complete removal and disposal of the entire length of pipe and backfill and compaction of the void with ordinary borrow. When the void is within the footprint of the new building, gravel borrow (structural fill if specified in Section 312000 – EARTH MOVING) shall be used to backfill the void.

E. Utility structures designated to be abandoned in place shall have their cast iron castings removed and disposed, inlet and outlet pipes plugged, the bottom of the structures shall be broken, the void of the structure shall be backfilled and compacted with ordinary borrow, and the top of the structure shall be removed so that it is at least 36 inches below the interim and final finished grades of the Project.

F. Utility structures designated to be removed shall consist of the removal and disposal of cast iron castings, plugging of inlet and outlet pipes, removal of the structure, and backfill and compaction of the void with ordinary borrow. When the void is within the footprint of the new building, gravel borrow (structural fill if specified in Section 312000 – EARTH MOVING) shall be used to backfill the void.

3.4 CLEARING, GRUBBING AND TREE REMOVALS

A. Where tree removal is designated on the Drawings, remove completely all trees, root systems and stumps below grade and as directed by the Owner's Representative. Stumps shall be removed at a 2' depth minimum below existing finish grade.

1. Chips from the stump material shall be removed and disposed of off-site.
2. Backfill all holes from which stumps are removed with material equal to or better than adjacent areas and compact in accordance with Section 31 00 00 - EARTHWORK, of these Specifications. Do not use brush, chips, stumps or other organic debris as fill for these holes.
3. Fell trees in such a way as to not injure trees to be saved. Excavation or grading within the branch spread of trees to be saved shall be performed only under the direction of the Owner's Representative unless otherwise directed.
4. Roots 3 inches and larger shall be removed to a depth of 2 feet below finished grade. Stumps shall be legally disposed of off-site.

B. In all other locations shrubs, stumps, grasses, turf, herbaceous plants, wood mulch, organic matter, miscellaneous vegetation, downed trees or extraneous debris not indicated on the Contract Documents or designated in the field by the Owner's Representative to remain shall be cleared and grubbed.

3.5 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil and other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil materaisl 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.

1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within tree protection zones.

3.6 EXCESS TOPSOIL

A. Topsoil that has been stripped and stockpiled, but is not needed after the completion of all final topsoil spreading and grassing, shall be removed and legally disposed of off site by the Contractor per all local, state, and federal standards.

3.7 TEMPORARY EROSION CONTROL AND SEDIMENTATION CONTROLS

A. See Section 01 57 13 – TEMPORARY EROSION AND SEDIMENTATION CONTROLS.
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3.8 REMOVALS, SAWCUTTING, SALVAGE AND DISPOSAL

A. Within the actual construction area, remove all existing obstructions such as chain link fencing and flagpoles, which are to be abandoned to at least 2 feet below final finish grades and to greater depths as required by new construction.

1. The use of explosives will not be permitted.
2. At the Owner's discretion, certain obstructions may not be removed to full depth if removal, in the Owner's opinion, will negatively affect materials to remain.

3. Backfill all holes from which obstructions are removed with material equal to or better than adjacent areas and compact in accordance with Section 31 00 00 - EARTHWORK, of these Specifications. Do not use brush, chips, stumps or other organic debris as fill for these holes.

B. The Contractor shall be responsible for the methods used in this work including properly protecting against damage to all site improvements, utility lines, trees, etc. Check with the municipality and local utility companies for locations of all existing utilities which may be in use or abandoned. Investigate and ascertain that underground utilities are correctly located and that they have been shut off and/or abandoned before disturbing them.

C. Sawcut all bituminous concrete and concrete paving with an approved diamond blade concrete saw on a neat, straight line to the dimensions given, or directed. Remove the portion behind the cut with proper tools, keeping noise and disturbance to a minimum.

1. All sawn edges of paving shall be protected from damage until new paving is placed against it. Existing pavement which is damaged, disturbed or settled, shall be cut back by the same method and replaced as directed and at no additional cost to the to the Owner. This Item shall include the removal of all layers of pavement and of gravel or other base or sub-base materials as required beneath pavements removed. Cut all bituminous with an approved diamond blade concrete saw on a neat, straight line to the dimensions given, or directed. Remove the portion behind the cut with proper tools, keeping noise and disturbance to a minimum.

D. Legally dispose of all demolished material not to be reused and rubbish off the site. Provide Owner with written affidavits confirming legal disposal. On site burning will not be allowed.

E. Salvage:

1. The Owner retains the first right of refusal of anything found on the site.
2. Metal signs.

3.9 DUST CONTROL

A. Throughout the construction period, Contractor shall carry on an active program for the control of fugitive dust within all site construction zones, or areas disturbed as a result of construction. Control methods shall include the following: Apply calcium chloride at a uniform rate of one and one-half (1 ½) pounds per square yard in areas subject to blowing. For emergency control of dust apply water to affected areas. The source of supply and the method of application for water are the responsibility of the Contractor.

B. The frequency and methods of application for fugitive dust control shall be as directed by the Owner’s Representative.

END OF SECTION

SECTION 03 30 00 – CAST IN PLACE CONCRETE

PART 1 – GENERAL

1.1 REFERENCE

A. Attention is directed to the printed form of the Contract of the City of Worcester and Division 1 of which these specifications are hereby made a part.

1.2 SECTION INCLUDES

A. Provide all equipment and materials, and do all work necessary to complete the work which includes, but is not limited to the following:

1. Furnishing, placing, curing and finishing of all new concrete pads, grade beams, paving and mow strips.
2. Furnishing, placing, curing and finishing of all new footings for site improvements
3. Furnishing, placing, curing, and finishing of all new sculpture bases.
3. Erection and removal of form work.
4. Pouring and curing of concrete.

1.3 RELATED WORK

A. The following items of related work are specified and included in other Sections of the Specifications:

1. Section 05 50 00 – Metal Fabrications
2. Section 26 00 00 - Electrical
3. Section 31 00 00 - Earthwork
4. Section 32 12 16 - Bituminous Concrete Paving
5. Section 32 30 00 - Site Improvements

1.4 REFERENCES

A. MassDOT: "Standard Specifications for Highways and Bridges", Massachusetts Department of Transportation, latest edition.
B. City of Worcester Department of Public Works and Parks, ‘Special Conditions and Specifications’, latest edition.
C. AASHTO: American Association of State Highway and Transportation Officials.
D. ACI 306: Recommended Practice for Cold Weather Concreting.
E. ACI 315: Manual of Standard Practice for Detailing Concrete Structures.
F. ACI 347: Recommended Practice for Concrete Formwork.
G. ACI 604: Recommended Practice for Winter Concreting.
H. ACI 605: Recommended Practice for Hot Weather Concreting.
I. ACI 614: Recommended Practice for Measuring, Mixing and Placing Concrete.
J. ASTM C94: Standard Specification for Ready Mixed Concrete, American Society for Testing and Materials.
K. ASTM C143: Standard Method of Test for Slump of Portland Cement Concrete.
L. AWS D1.3 Structural Welding Code - Sheet Steel
M. AWS D1.6 Structural Welding Code - Stainless Steel
N. Federal Specifications (Fed. Spec.): SS-S-1401C Sealing Compound, Hot Applied, for Concrete and Asphalt Pavements.

1.5 QUALITY ASSURANCE

A. Codes and Standards: Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified:
   1. Massachusetts State Building Code, Latest Edition.
   2. ACI 117-90 "Standard Specifications for Tolerances for Concrete Construction and Materials".
   3. ACI 214 "Recommended Practice for Evaluation of Strength Test Results of Conc."
   4. ACI 311 "Guide for Concrete Inspections".
   5. ACI 211.1-91 "Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete".
   6. ACI 211.2 "Guide for Selecting Proportions for No Slump Concrete".
   7. ACI 304 "Guide for Measuring, Mixing, Transporting and Placing Concrete".
   8. ACI 302 1R-96 "Guide for Concrete Floor and Slab Construction".
   9. ACI 305 R-99 Hot Weather Concreting.
   10. ACI 306 R-97 Cold Weather Concreting.
   11. ACI 308-97 Standard Practice for Curing Concrete.
   12. ACI 347 R-99 "Guide to Formwork of Concrete".
   13. ACI 309 "Guide for Consolidation of Concrete".
   14. The ACI Field Reference Manual, SP-15 shall be kept at the job site, and the practices set forth therein shall be strictly adhered to.
   15. ASTM C 494 Standard Specification for Chemical Admixtures for Concrete.
   16. ASTM C 309 Liquid Membrane-Forming Compounds.

B. Concrete Testing Service: Owner will engage a testing laboratory acceptable to Owner's Representative to perform material evaluation tests and to design concrete mixes.

C. Materials and installed work may require testing and retesting at anytime during progress of work. Tests, including retesting of rejected materials for installed work, shall be done at Contractor's expense.

D. HANDICAP ACCESSIBLITY: When installed, all paving shall be handicap accessible and will comply with the Civil Rights Restoration Act of 1987 and the Americans with Disabilities Act of 1990, with amendments effective Jan. 1, 2009.

1.6 PROJECT CONDITIONS

A. The Contractor, before commencing work, shall examine all adjoining work on which this work is in any way dependent for proper installation and workmanship according to the intent of this specification, and shall report to the Owner's Representative any condition that prevents this contractor from performing first class work.

B. Protection of Footings against Freezing: Cover completed work at footing level with sufficient temporary or permanent cover as required to protect footings and adjacent subgrade against possibility of freezing; maintain cover for time period as necessary.

C. Protect adjacent finish materials against spatter during concrete placement.

D. Provide all barricades and safeguards at all pits and holes etc. to prevent injury to workmen and others within and about the premises. Also provide all safeguards as required by the Building Code, OSHA, or any other departments having jurisdiction. Take full responsibility for all safety precautions and methods.

E. Procedure of Work: The contractor shall keep himself constantly informed as to the progress of the work in the field, materials and men ready to start work immediately when conditions of

preceding work are available or ready, wholly or in part, so as not to delay the progress of building work or to interfere with the progress of work of other contractors, and in any event he shall, within 24 hours after notice from the Owner, proceed with such work as directed to maintain the uninterrupted progress of the work.

1.7 QUALITY ASSURANCE

A. Comply with all laws, rules and regulations of governmental authorities having jurisdiction over concrete work. Design all concrete work in accordance with the applicable specifications and standards specified herein.

1. Contractor will be required to provide information demonstrating successful use in prior placement involving all admixtures.

1.8 SUBMITTALS

A. PRODUCT DATA: Submit data for proprietary materials and items, including forming accessories, admixtures, joint systems, curing compounds, and others as requested by Owner’s Representative.

B. Test reports on placed concrete:

1. Slump tests.
2. 7, 14 and 28 day compression cylinder tests.
3. Field tests as specified herein.

C. Manufacturer's certificates and data on any items requested by Owner’s Representative.

D. Laboratory Test Reports: Submit test reports for concrete design mix including report on design strength test and slump test.

E. Shop Drawings:
a. Sculpture Bases: Provide complete shop drawings for the sculpture bases showing all dimensions, appurtenances, hardware, lighting and locations and sizing of associated conduit, layout of sculpture anchors, and all other associated elements for approval prior to construction. Coordinate shop drawing of base with shop drawing of metal anchors as described in Section 05 50 00, METAL FABRICATIONS.

1.10 TESTING LABORATORY SERVICE

A. The testing laboratory will be responsible for conducting and interpreting tests. Each report shall state whether or not the test specimens conform to all requirements of the Contract Documents and will specifically note any deviation there from if any. Specific test and inspection requirements shall be as specified herein.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Forms for Finish Concrete: Unless otherwise indicated, construct forms of plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings. Provide form material with sufficient

strength and thickness to withstand pressure of newly placed concrete without bow or deflection and to retain horizontal and vertical alignment until removal.

1. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood", Class I, Exterior Grade or better mill oiled and edge-sealed, with each piece bearing legible inspection trademark.
2. Use flexible spring steel forms or laminated boards to form radius bends as required.
3. Sculpture bases: Forms for sculpture bases shall use a new smooth formliner finish for all exposed surfaces.

B. Form Coatings: Provide VOC compliant 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. Provide a ½" chamfer on all exposed edges of finished concrete.

D. Form Oil: Nonstaining type specifically manufactured for concrete forms.

E. Form Ties: Form ties and spreaders: prefabricated assemblies by Richmond; Superior, Dayton or approved equal. Wire ties SHALL NOT BE USED.

2.2 CONCRETE MATERIALS

A. CONCRETE FOR FOOTINGS AND FOUNDATIONS

1. Portland Cement: ASTM C 150, Type I, for exposed work and Type I or II for concealed work. Use one brand of cement throughout project, unless otherwise acceptable to Owner's Representative.

B. CONCRETE PAVING

1. Cement concrete shall be of an air entrained type conforming to the current specifications of Section M4 of the Massachusetts Standard Specifications for Highways and Bridges. Cement concrete shall have a 28-day compressive strength of 4,000 PSI using 3/4 inch aggregate, and with an entrained air content of 7.0 $\pm$ 1.0%.

    a. Upon delivery of each and every concrete mix, the Owner's Representative shall be furnished with a slip clearly stating the design mix and the quantities of the above mentioned add mixture, and any other add mixtures present in the mix. Any concrete mix, which when tested on the job site is found to contain quantities of entrained air less than six (6) or more than eight (8) per cent or which yields a slump of less than three (3) inches or greater than five (5) inches shall be rejected, the decision of the Owner's Representative shall be final. The Owner's Representative reserves the right to change the above mix in order to meet the required strength test.
    b. All concrete shall be transit mix and shall conform to the current specifications of ASTM C-94. Hand mix concrete or machine mixed on the job concrete shall be used only when permitted by the City Owner's Representative in writing.

C. Water: conforming to Section M4.02.04 of MassDOT.

D. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

1. Products: Subject to compliance with requirements, provide one of the following: "Air-Mix or AEA 92", by Euclid Chemical Co.

"MB-VR or MB-AE", by Master Builders.
"Sika Aer", by Sika Corporation.
"Darex II AEA" or "Daravair", by W. R. Grace.

E. Water-Reducing Admixture: ASTM C 494, Type A, and containing not more than 0.05 percent chloride ions.

1. Products: Subject to compliance with requirements, provide one of the following:
"Eucon WR-75, WR-89 or MR", by Euclid Chemical Co.
"Pozzolith 322N", by Master Builders.
"Plastocrete 161", by Sika Corporation.
"WRDA with Hycol", by W. R. Grace.

F. Color Admixture in Concrete Paving: Ordinary or emulsified carbon black at a ratio of 8 parts concrete :1 part carbon black, unless otherwise directed by the Owner's Representative.

1. Upon delivery of each and every concrete mix, the Engineer shall be furnished with a slip clearly stating the design mix and the quantities of the above mentioned add mixture, and any other add mixtures present in the mix.

G. Prohibited Admixtures: Calcium chloride, thyocyanates or admixtures containing more than 0.05 percent chloride ions are not permitted.

H. Certification: Written conformance to the above-mentioned requirements and the chloride ion content of admixtures will be required from the admixture manufacturer prior to mix design review by the Engineer.

2.3 METAL REINFORCEMENT

A. Welded Wire Mesh: conforming to Sections M8.00.0, M8.01.0 and M8.01.2 of MassDOT except as herein modified. Furnish welded wire mesh in flat sheets, not rolls.

1. Reinforcing and accessories shall be free of excessive rust, scale or other coatings that will reduce bond.

B. Joint Dowel Bars: AISI Type 304 stainless steel plain round bars. Saw cut bars as required, free from burrs or out of round ends. Coat bars in accordance with AASHTO M254.

C. Dowel Caps: plastic having a closed end with a stop to hold the end of the sleeve at a minimum distance of 1 inch from the end of the dowel bar.

D. Wire Ties: 18 gauge stainless steel or galvanized annealed wire conforming to ASTM A82.

E. Bar supports, metal accessories and other devices necessary for proper assembly of concrete reinforcing shall be of standard factory-made wire bar supports conforming to Product Standard PS7-766, National Bureau of Standards, Department of Commerce, Class C. Accessories touching concrete surfaces shall have 1/4 inch of high density polyethylene tips between metal and concrete surface extending not less than 1/2 inch up on metal legs.

2.4 CONCRETE PROPORTIONING, MIXING, STRENGTH AND QUALITY

A. Concrete shall conform to ASTM C94. The design strength of concrete shall be as follows:

1. 4,000 psi minimum at 28 days for above grade use, including all sculpture bases.

2. 3,000 psi minimum at 28 days for below grade use.

B. All concrete exposed to weather shall be air entrained with a total air content of 5 to 8%.

C. Use no more water in the mixture than is necessary to produce concrete that is workable and plastic within the limits specified herein for slump. Use the least amount of water and proportion of mortar to coarse aggregate that will produce uniformly dense concrete, free from aggregate pockets or honeycomb. Make corrections for the amount of moisture contained in the aggregates. Make allowances for absorption of moisture by the aggregates during the period of mixing and handling. Maintain a continuous uniform consistency.

D. In all cases, provide concrete of such consistency and mix composition that it can be worked readily into the corners and angles of forms and around reinforcement, concrete inserts and castings without permitting the materials to segregate or free water to collect on the surface.

E. The consistency of the concrete at time of deposit as measured by ASTM C143 shall be as follows:

PORTION OF WORK	SLUMP RECOMMENDED	SLUMP MAXIMUM RANGE
Base slabs on ground	2-1/2 inches	2-3 inches
Footings	3 inches	2-4 inches

2.5 CONCRETE MIXING

A. Concrete shall be Ready-Mix Concrete: Comply with requirements of ASTM C 94, and as herein specified.

B. Provide batch ticket for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.

C. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94 may be required. When air temperature is between 85°F (30°C) and 90°F (32°C), reduce maximum mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90°F (32°C), reduce maximum mixing and delivery time to 60 minutes.

D. Cold weather mixing procedures shall be submitted to the Owner’s Representative for approval.

E. No water shall be added after mixing to concrete containing HRWR (Superplasticizer). If loss of slump occurs, the concrete treated with HRWR may be re-dosed as long as a "flash set" has not occurred. Re-dosage procedures must be discussed and approved by the Engineer and the manufacturer.

2.6 MISCELLANEOUS MATERIALS

A. Non-Shrink, Non-Metallic Grout: The non-shrink grout shall be a factory pre-mixed grout and shall conform to ASTM C1107. It shall be selected from one of the following:

1. "Euco-NS", by Euclid Chemical Co.
2. "Five Star Grout", by Five Star Products, Fairfield CT.
3. "Masterflow 713" by Master Builders.
4. or approved equal.

B. Moisture-Retaining Blanket for concrete curing complying with ASTM C 171:

1. 'Hydra-Cure S-16' as distributed by A. H. Harris, Dorchester MA, tel: 617-269-4800, or approved equal.
2. Polyethylene sheeting
3. Burlap

C. Non-Shrink, Non-Metallic Grout: Sikaflex 110 joint sealant.

D. Fine Aggregate: conforming to Section M4.02.02 of MassDOT.

E. Coarse Aggregate: conforming to Section M4.02.03 of MassDOT except that 3/4 inch shall be the maximum aggregate size.

F. Sculpture Anchors: See Section 05 50 00, METAL FABRICATIONS.

G. Preformed Expansion Joint Filler for shall be non-extruding and resilient non-bituminous type conforming to AASHTO-M135.

PART 3 – EXECUTION

3.1 GENERAL

A. Install concrete conforming to requirements of Section 476 of MassDOT except as herein modified.

3.2 SUBGRADE AND BASE COURSE PREPARATION

A. Excavation and subgrade preparation, including placement of base course, shall be in accordance with Section 31 00 00 EARTHWORK of these Specifications. Do not build up subgrade after forms are in place.

1. Any area that is inaccessible to mobile mechanical equipment or in restricted areas shall be compacted with pneumatic rammers or powered hand tampers.

B. Make any corrections necessary to gravel borrow furnished and installed under Section 31 00 00 - Earthwork, to the sections and elevations as shown on the Drawings.

3.3 FORM CONSTRUCTION – PAVEMENT

A. All concrete pavement shall be constructed with the use of side forms. The forms shall be clean, smooth and free from warp. Design, erect, support, brace and maintain formwork to support vertical and lateral, static, and dynamic loads that might be applied until such loads can be supported by concrete structure. Construct formwork so that concrete members and structures are of the correct size, shapes, alignment, elevation and position. Maintain formwork construction tolerances complying with ACI 347. Provide Class C tolerances for other concrete surfaces.

1. Design formwork to be readily removable without impact, shocks or damage to cast-in-place concrete surfaces and adjacent materials.

3.4 FORM CONSTRUCTION – FOUNDATIONS

A. Set forms to required lines, grades and dimensions shown, plumb and straight, rigidly braced and secured. Install sufficient quantity of forms to allow continuous progress of work, and so that forms can remain in place at least 72 hours after concrete placement. Use smooth forms, free from warp. Check completed formwork for grade and alignment to the following tolerances:

1. Top of forms: Not more than 1/8 inch in 10 feet.
2. Vertical face on longitudinal axis: Not more than 1/4 inch in 10 feet.

B. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only.

C. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items built into forms.

D. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is placed. Retightening forms and bracing after concrete placement is required to eliminate mortar leaks and maintain proper alignment.

3.5 PLACING REINFORCEMENT AND COORDINATION WITH OTHER TRADES

A. Locate, place and support reinforcement accurately as shown on the Drawings. Provide 18 gauge wire ties at the intersection of all reinforcement. Lap all mesh reinforcement 6 inches. Place reinforcing and accessories in accordance with CRSI Standards 63 and 68.

B. Coordinate the installation of all anchor bolts, inserts and imbedded items required by other trades prior to pouring concrete. Do not cut or displace any reinforcement.

3.6 SETTING SCULPTURE ANCHORS

A. General: Locate, place and support metal sculpture anchors accurately as shown on the Drawings. Anchors shall be set true and square and at a height where the surface is flush with the top of the finished concrete. Firmly brace the anchors to not shift, adjust, or move during concrete placement. Any bracing shall be of a metal or material that will not pose adverse chemical reactions in the concrete.

B. See Section 05 50 00, METAL FABRICATIONS.

3.7 CONCRETE PLACEMENT

A. Ready-mix concrete shall comply with the requirements of ASTM C94 and ACI 304. All plant and transporting equipment shall comply with the concrete plant standards and truck mixer and agitator standards of the National Ready Mix Concrete Association.

B. Notify Owner’s Representative and testing organization at least 36 hours (1 1/2 regular working days) before each pour so that forms and reinforcing may be examined. Do not place concrete until inspection has been made or waived.

C. Pre-placement Inspection: Before placing concrete, inspect and complete formwork installation, and items to be embedded or cast-in. Notify other crafts to permit installation of their work;

cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.

D. General: Comply with ACI 304 "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete", and as herein specified. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete that has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.

E. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 18" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints. Use internal vibrators penetrating both the top and preceding layers.

F. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309 "Recommended Practice for Consolidation of Concrete". Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6" into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set.

G. Construct contraction joints at the locations as indicated on the Drawings. Score the surface uniformly into block units of areas not more than 36 square feet unless otherwise indicated on the Drawings.

1. Score joints in concrete walks will be sawn. Form contraction joints with poser saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks. Cut within 24 hours. The depth of scoring shall be at least 1/4 of the thickness of the paving.

I. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.

1. When air temperature has fallen to or is expected to fall below 40°F (4°C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50°F (10°C), and not more than 80°F (27°C) at point of placement.

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. Use only a non-corrosive, non-chloride accelerator. Calcium chloride, thiocyanates or admixtures containing more than 0.05% chloride ions are NOT permitted.

J. 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.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90°F (32°C). Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor's option.

2. Use water-reducing retarding admixture (Type D) when required by high temperatures, low humidity, or other adverse placing condition.

3.8 CONCRETE – COMPRESSIVE STRENGTH

A. Concrete shall develop the minimum compressive strength at 28 days when sampled and tested in accordance with ASTM C31 and C39 with the maximum slump in accordance with the approved mix design.

3.9 CONCRETE CURING AND PROTECTION

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Protect and cure finished concrete using moist curing methods for initial curing whenever possible in accordance with ACI 301. Protect from drying out by covering with concrete curing blankets, polyethylene sheeting, or wet burlap.

C. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least 7 days in accordance with ACI 301 procedures. Perform curing as soon as possible after concrete placement and in any event within 12 hours. Keep concrete continuously moist for a period of 7 days and maintain at a temperature of at least 50 degrees.

D. Do not use commercial type curing agents which might discolor or otherwise damage the surface.

E. Allow concrete to cure for a minimum of 14 days before the erection of load bearing units on anchor bolts, plates, etc.

F. Curing Method: Perform curing of concrete by curing and sealing compound, by moist curing, by moisture-retaining cover curing, and by combinations thereof, as herein specified.

1. Provide moisture-cover curing as follows:
   a. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3.10 REMOVAL OF FORMS

A. Formwork not supporting weight of concrete may be removed after cumulatively curing at not less than 50°F (10°C) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.

B. Formwork supporting weight of concrete, such as slabs and other structural elements, may not be removed in less than 14 days and until concrete has attained design minimum compressive strength at 28-days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.

3.11 CONCRETE FINISHING

A. It is the intent of this Specification to require forms, mixture of concrete and workmanship so that concrete surfaces, when exposed, will require no patching. Remove any concrete which is not formed as shown the Drawings or for any reason is out of alignment or level, or shows a defective surface, unless Owner's Representative grants permission to repair the defective area. Permission to patch any such area shall not be considered a waiver of Owner's Representative's right to require a complete removal of defective work if the repair does not, in his opinion, satisfactorily restore the quality and appearance of the surface. The Owner's Representative shall be the sole judge of appearance as such relates to artistic effect.

B. Do not dust the concrete surface with dry cement or sand during finishing except as herein specified. Any excess "puddling" shall be cause to reject the total section of concrete. Perform no finish operation while free water is present. Delay jointing and edging operations until all bled water and water sheen has left the surface.

C. After striking off and consolidating concrete, smooth the surface by screeding and floating with an aluminum or magnesium float. Adjust the floating to compact the surface and produce a uniform texture.

D. After floating, test the surface for trueness with a 10 foot straightedge. Distribute the concrete as required to remove surface irregularities, and refloat all repaired areas to provide a continuous smooth finish. Work edges of slabs and joints with a 1/8 inch radius edging tool. After edging and jointing operations, refloat the surface. After completion of floating, and when excess moisture and surface sheen have disappeared, complete surface finishing as follows:

1. Light Broom Finish: Immediately following floating, steel trowel the surface. Use a stiff bristled wire broom, with a long handle, to obtain a light broom finish. Install brush marks true to the direction indicated on the Drawings or perpendicular to the flow of traffic if not shown. Repeat edging and jointing operations as required to obtain a distinct edge.
2. Rough Form Finish: For formed concrete surfaces not exposed-to-view, unless otherwise indicated. This is the concrete surface having texture imparted by form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4" in height rubbed down or chipped off.

E. Final concrete finishes.

1. Walk Paving: light broom finish.
2. Bench Pads: light broom finish.
3. Concealed surfaces: rough form finish.
4. Sculpture Bases: smooth formliner finish.
   a. Surfaces with formliner finishes shall comply with manufacturer photos and details.

F, Chamfer all exposed edges in accordance with this Specification.

3.12 REPAIR AND PROTECTION AFTER INSTALLATION

A. Repair and replace any broken or defective concrete as directed. Protect concrete from damage until acceptance of the work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing stains and spillage of materials as they occur. Sweep concrete and wash free of stains, discolorations, dirt and other foreign material just prior to final inspection.

B. Remove broken or defective concrete paving by cutting back to the nearest score line or expansion joint, to leave a straight and true edge.

C. If, in the opinion of the Owner's Representative, the foregoing tests indicate concrete strengths below those required, or visual defects indicate concrete of poor quality has been placed, additional tests shall be made and reported as directed by the Owner's Representative at expense of Contractor. No patching or parging of new concrete work is allowed.

D. Remove and replace pavement sections found deficient by 1/2 inch or more in thickness at no additional cost to the Owner.

3.13 CUTTING AND PATCHING

A. Contractor for concrete work shall be responsible for all cutting, removing and patching work where concrete surfaces are not installed within the limits shown on the drawings or specified herein. All such work shall meet with the approval of the Owner's Representative.

B. Where cutting and patching is required to accommodate the work of other subcontractors, such cutting shall be done at the expense of said subcontractors but shall be performed by the contractor for concrete work.

C. The location and extent of cutting in completed concrete work and the patching thereof shall meet with the approval of the Owner's Representative.

3.14 TESTING LABORATORY RESPONSIBILITIES

A. The Contractor will employ a testing laboratory to perform tests and to submit test reports.

B. Sampling and testing for quality control during placement of concrete shall include the following, as directed by Owner's Representative:

1. Slump: ASTM C 143; one slump test at point of discharge for each truck.

2. Compression Test Specimen: ASTM C 39; set for each day's pour exceeding 25 cu. yards plus additional sets for each 50 cu. yards over and above the first 25 cu. yards of each concrete class placed in any one day; one specimen shall be tested at 7 days, three specimens shall be tested at 28 days and one specimen shall be retained in reserve for later testing if required. One cylinder will stay at the site.

C. Design the mix for the concrete to obtain a strength, as determined by test cylinders, at least 15% higher than specified.

D. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.

E. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 500 psi.

F. Test results will be reported in writing to Owner's Representative, Owner and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day tests and 28-day tests.

G. Non-Compliance: All test reports indicating non-compliance shall be faxed immediately to all parties on the test report distribution list and the hard copies submitted on different colored paper.

H. Nondestructive Testing: Windsor probes, sonoscope, or other non-destructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.

I. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Owner's Representative. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such tests when unacceptable concrete is verified.

END OF SECTION

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SECTION 04 00 00 - MASONRY

PART 1 - GENERAL

1.1 REFERENCE

A. Attention is directed to the printed form of the Contract of the City of Worcester and Division 1 of which these specifications are hereby made a part.

B. Examine all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.

1.2 DESCRIPTION OF WORK

A. The work of this Section includes but is not limited to all masonry work required for the complete installation of the following:

1. New Fieldstone Seat Wall
2. Stepping Stones

1.3 RELATED WORK

A. Section 02 41 13 - Site Preparation
B. Section 03 30 00 - Cast in Place Concrete
C. Section 31 00 00 - Earthwork

1.4 DEFECTIVE MATERIALS

A. Do not install defective materials. No patching or hiding of defects will be permitted. Refer to Owner’s Representative for decision on all materials showing flaws or imperfections upon delivery to the job site. The Owner’s Representative's decision as to rejection of materials shall be understood to be final. Remove rejected material from the site and replace with new material.

1.5 QUALITY ASSURANCE

A. Engage an installer who has successfully completed within the last 3 years at least 6 applications similar in type to that of this project and who will assign mechanics from these earlier applications to this project, of which one will serve as lead mechanic.

B. Construction Tolerances:

1. Variations from plumb: 1/4 inch in 10 feet.
2. Variations from level: 1/4 inch in 20 feet.
3. Variation of linear line: 1/2 inch in 20 feet.

C. Quality Control

1. All new stone shall be provided in strict accordance with samples approved by Owner’s Representative.
2. All finishes, dimensions and tolerances shall meet both industry standards and those indicated on approved shop drawings and samples.
3. All stone used shall be sound and free from cracks, seams or starts that might impair its structural integrity or function.

4. No patching shall be permitted except with the approval of the Owner’s Representative.

D. Stone Sources: All stone shall be obtained from one source that is shown to be able to meet project requirements. The specified source shall have adequate capacity and facilities to meet the project requirements.

1. Any source used is subject to approval of the Owner’s Representative.

1.6 SUBMITTALS AND SAMPLES

A. Submit manufacturer's catalog data and specification sheets for all stone types, accessories, mortar, and other manufactured products, including certifications that each type complies with specified requirements.

B. Submit stone samples for:

1. For New Fieldstone Wall: Submit photograph or actual sample of fieldstone, 12” square x 6” minimum.

2. Stepping Stones. A minimum one photograph of each selected stone, indicating measurements in both directions, shall be submitted for approval prior to ordering.

C. Masonry mortar samples showing full range of colors available.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Packing and Loading of Stone: Carefully pack and load finished stone for shipment using all reasonable and customary precautions against damage in transit. Do not use any material which may cause staining or discoloration for blocking or packing.

B. Site Storage of Stone: Upon receipt at the construction site or storage yard, stack the stone on timber platforms at least 4" above the ground. Take extreme care to prevent staining during storage. If storage is to be for a prolonged period, place polyethylene or other suitable plastic film between any wood and finished surfaces. Use also as an overall protective covering. Plug Lewis holes during freezing weather to prevent the accumulation of water. Do not use salt for the melting of ice formed in Lewis holes or on pieces, or for any purpose involving its contact with the stone.

C. Protect stone during storage and construction against moisture, soiling, staining and physical damage.

1. Handle to prevent chipping, breakage, soiling or other damage. Do not use pinch or wrecking bars without protecting edges with wood or other rigid materials. Lift with wide-belt type slings wherever possible. Do not use wire rope or ropes containing tar or other substances which might cause staining. If required use wood rollers and provide cushion at end of wood slides.
2. Store on wood skids or pallets, covered with non-staining, waterproof membrane. Place and stack to distribute weight evenly and to prevent breakage or cracking. Protect stored materials from weather with waterproof, non-staining covers or enclosures, but allow air to circulate around materials.

D. Deliver masonry materials in undamaged condition. Deliver cleaning materials to site in manufacturer's original unopened containers and packaging, bearing labels as to type and names of products and manufacturers.

E. Store cementitious materials off the ground, under cover and in dry location.

F. Store aggregates where grading and other required characteristics can be maintained.

G. Protect mortar materials and stone accessories including metal items to prevent deterioration by corrosion and accumulation of dirt.

1.8 PROJECT CONDITIONS

A. Staining: Prevent mortar from staining the face of stone to be left exposed. Remove mortar immediately in contact with such stone.

B. Remove all stone determined to be frozen or damaged by freezing conditions.

C. During cleaning protect persons, motor vehicles, construction site and buildings from injury resulting from stone cleaning work.

1. Protect all non-stone surfaces. Review all protective measures with Owner’s Representative for approval.
2. Prevent cleaning solutions from coming into contact with pedestrians, motor vehicles, plant materials, buildings and other surfaces which could be injured by such contact.
3. Do not clean stone during winds of sufficient force to spread cleaning solutions to unprotected surfaces.
4. Dispose of run-off from cleaning operations by legal means and in a manner which prevents soil erosion, undermining of paving and foundations, and damage to adjacent landscaping.

D. During erection of stone, cover top of walls with heavy waterproof sheeting at end of each day's work. Cover partially completed structures when work is not in progress. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.

E. Do not apply concentrated loads for at least 3 days after building masonry walls.

F. Prevent grout or mortar from staining the face of masonry to be left exposed. Immediately remove grout or mortar in contact with such masonry.

1.9 COLD WEATHER PROTECTION

A. Do not erect or clean any stone when temperature of surrounding area is below 40 degrees F., or below 45 degrees F. and falling, or forecast by public news media to fall to or below 35 degrees F. within 24 hours without temporary heated enclosures or without heating materials or other precautions necessary to prevent freezing. Minimum temperature within heated enclosure shall be 40 degrees F. Do not use masonry materials which are likely to contain frost. Do not use accelerating ingredients with any mortar. Do not use anti-freeze compounds to lower the freezing point of mortar. Mortar shall harden without freezing and with no damage from frost. Protect all masonry against freezing for not less than 48 hours after installation.

B. Do not lay stone units which are wet or frozen. Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen setting beds. Remove any ice or snow formed on masonry bed by carefully applying heat until top surface is dry to the touch. Remove and replace masonry work damaged by frost or freezing.

C. Comply with requirements of International Masonry All-Weather Council's "Guide Specification for Cold-Weather Masonry Construction". Heat materials and provide temporary protection of completed portions of masonry work.

1.10 HOT WEATHER PROTECTION

A. Protect masonry work in hot weather to prevent excessive evaporation of mortar setting beds. Provide artificial shade, wind breaks and use cooled materials as required. Use fresh mortar. Discard mortar which has stiffened due to hydration.

PART 2 - MATERIALS

2.1 NEW STONE SEAT WALL

A. Stone as required for new wall construction shall be a wall stone equal to Princeton Fieldstone as provided by Plymouth Quarries, 410 Whiting St., Hingham MA, Phone: (781) 335-3686, or approved equal. Stones shall present weathered exposed surfaces when built into walls.

B. Wall stone shall be a combination of sizes ranging from ‘one man’ to ‘two man’ stones with the larger size comprising more than 50% of the stones.

C. Stones shall be carefully picked up and moved using only nylon straps to avoid scratching the weathered surface of stone.

2.2 NEW STEPPING STONES

A. Stone as required for new stepping shall be equal to Princeton Fieldstone, as provided by Plymouth Quarries, 410 Whiting St., Hingham MA, Phone: (781) 335-3686, or approved equal.

1. Stepping Stones shall be angular shaped, roughly irregular, and with a minimum of 15” x 15” in size. One surface shall be level for stepping on.

2.3 STONE ACCESSORIES

A. Stone anchors: Type and size indicated or, if not indicated, as required to securely anchor and fasten stonework in place. Fabricate anchors, cramps and dowels from AISI Type 302/304 stainless steel. Relying on adhesives alone for anchoring will not be allowed.

B. Setting buttons: Lead or plastic buttons of the thickness required for the joint size indicated, and of the size required to maintain uniform joint width.

2.4 MORTAR MATERIALS

A. Mortar for fieldstone walls shall be composed of 3 parts sand and 1 part Portland cement by volume with sufficient water to form a workable mixture.

1. Portland cement shall conform to ASTM C150, Type II. Provide natural color or white cement as required to produce mortar color to match existing work in one or more areas.

2. Lime: ASTM C207, special finishing hydrated lime, Type S, non-air entrained, Minuteman preferred.

3. Aggregate for Mortar: Non-staining sand, ASTM C144, or ASTM C404, Size No. 2 except for joints 1/4 inch and less (if any) use aggregate graded with 100 percent passing No. 16 sieve. Provide well-graded bagged mason's mortar sand or other clean washed sand or crushed stone of size and color to match or blend visually with existing historic work as required. Provide each of the following:

    a. White silica sand with sharp grains.
    b. Light tan river sand with rounded grains.
    c. White/light grey river sand with rounded grains.

4. Colored Mortar Pigments; Natural and synthetic iron oxides and chromium oxides, compounded for used in mortar mixes. Use only pigments with record of satisfactory performance in masonry mortars. Do not use pigments that might adversely impact adhesion or strength of mortar. Owner’s Representative will not be limited to "standard" colors. Provide custom colors when color selected is not available as one of the following products:

    a. "Spectrum Custom Colors": S.B. Green & Co., Inc., Watertown, MA.
    b. "SGS Mortar Colors": Solomon Grind-Chem Services, Inc.
    c. Iron oxide pigments: Lander-Segal.
    d. Iron oxide pigments: Lansco.

5. Grout fill: ASTM C476.
6. Calcium chloride, other antifreeze materials and accelerators: NOT PERMITTED.
7. Water: Clean, potable, non-alkaline and free of deleterious materials which would impair strength or bond.

2.5 AGGREGATE BASE

A. Provide crushed stone base course as specified under Section 31 00 00 – Earthwork, in this Specification.

PART 3 - EXECUTION

3.1 INSTALLATION OF FIELDSTONE WALLS

A. Assemble and install fieldstone wall in accordance with the Drawings. Comply with width, thickness, pattern, radius and length requirements as shown and specified.

B. Execute stone work by skilled and competent stone setters in accordance with the approved shop drawings. Do necessary field cutting as stone is set. Cut stone as required with high speed masonry saw to provide clean, sharp edges and as required to fit neatly around all projections.

C. Clean stone before setting by thoroughly scrubbing with fiber brushes followed by a thorough drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh fillers or abrasives. If not thoroughly wet at time of setting, drench or sponge stone. Do not wet expansion or control joint surfaces.

D. Excavate to lines and grades shown on drawings and provide crushed stone foundation. Place fieldstone courses with overlapping joints such that all joints are covered with stones above and no vertical joint between stones travels more than 1/3 of the way upward through the wall. All stones shall be firmly placed and shimmed as required to be well locked together. Provide large

stones as rowlocks which tie front and back of wall together. Stones shall not be able to be removed after completion.

E. Lay wall stone with joints broken both horizontally and vertically. At least one stone shall project the full depth of the wall in any 2 foot by 3 foot square of vertical face area. Carefully fit all stones tightly together to expose a wall similar in appearance to drywall construction. Set stones in full mortar beds. Remove stones loosened after the mortar has taken initial set, clean mortar off and relay stone with fresh mortar. Carefully fit all stones tightly together to expose a wall similar in appearance to dry wall construction.

1. Stone placement: large stones and smaller sized stones shall be placed throughout the courses of the stones such that there are not areas which contain all the same sized stones, or contain all small stones or all large stones. Stone jointing shall be reasonably tight.

2. End and corner stones shall be large stones in order to securely anchor the ends and corners of the wall.

3. Do not use stone units with chips, cracks, voids, discolorations or other defects which might be visible or cause staining in the finished work. Keep exposed surfaces free of mortar, rubber and other deleterious substances at all times.

4. Remove and replace units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.

5. Set stones in top of wall in full mortar beds and carefully join the stones, ensuring that the joints are sufficiently tight and comparable to the wall faces.

F. Mortar shall not be visible at the exposed vertical faces of the stone wall. The Contractor shall carefully convey mortar such that the exposed faces of stones are not stained with mortar. Mortar shall be used in the interior of the wall to lock all stones together internally such that no exposed stone will be capable of being removed. Stones shall be of regular enough shape to fit together at exposed faces with a minimum of mortar showing.

1. Any mortar used in the interior construction of the wall shall be totally concealed.

2. Remove excess mortar from the surface before it sets using a bristle brush or by rubbing the surface with burlap or clean sand. If mortar is left on the surface, wash surface clean using dilute solutions of Hydroclean HT-455.

3. Unless otherwise shown on approved shop drawings, each piece shall be carefully bedded in a full bed of mortar and tapped home with a rawhide mallet to full and solid bearing.

4. Completely fill all joints and beds, then rake out to a depth of not less than 3/4". Take every precaution to prevent direct bearing contact between pieces.

3.2 POINTING OF NEW WORK

A. Pointing: Except where otherwise specified, brush clean all previously beds, and point with mortar to a flat cut joint. Wet joints before new mortar is applied. When thumbprint hard, tool the beds and joints with a round jointer having a diameter 1/4" larger than the width of the joint. Provide a neat, uniform appearance.

1. During the tooling of joints, enlarge any voids or holes and completely fill with mortar.

2. Point all open beds and joints for a depth of at least one inch.

3. At special locations, where so directed, point and finish joints and beds as the setting progresses.

B. Cut back and redo work judged defective by Owner's Representative at no additional cost.

3.3 CLEANING AND PROTECTION

A. After installation is completed, carefully clean all work, removing all dirt, excess mortar, stains and/or other site incidental defacements. Clean soiled masonry surfaces using a nonacidic solution which will not harm masonry or adjacent materials. Consult masonry manufacturer 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.

B. Protect work in progress and after completion. Keep the premises neat and clean at all times.

END OF SECTION

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DIVISION 05 - METALS

SECTION 05 50 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 REFERENCE

A. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.

1.2 SCOPE OF WORK INCLUDES

A. Furnish and install the following site improvements:

1. Metal Anchors for Sculpture bases

1.3 RELATED WORK

A. Section 02 41 13 - Site Preparation
B. Section 03 30 00 - Cast in Place Concrete

1.4 QUALITY ASSURANCE

A. Codes and Standards: Comply with the standards of the following associations except as otherwise required:

1. ADAAG Manual: US Architecture and Transportation Barriers Compliance Accessibility Guidelines, July 1998.
2. ASTM, American Society in Testing Materials, latest editions.
3. AWS (American Welding Society): D1.1 "Structural Welding Code" and "Standard Qualification Procedure".
4. AWS D1.3 Structural Welding Code - Sheet Steel
5. AWS D1.6 Structural Welding Code - Stainless Steel
4. MassDOT: "Standard Specifications for Highways and Bridges", Massachusetts Department of Transportation, latest edition.

B. Steel Materials: Provide steel chemically suitable for metal coatings complying with the following requirements: All metals for anchors shall be Grade 316 L Stainless Steel.

C. Fabricator Qualifications: Firms experienced in successfully producing metal fabrications similar to those indicated for this project, with sufficient production capacity to produce required units without causing delay in the work. Work shall be performed by a firm having not less that 10 years successful experience in comparable projects and employ personnel skilled in the processes and operations indicated and required.

D. Welding Qualifications: Quality processes and operators in accordance with AWS "Standard Qualification Procedure". Certify that welders have passed AWS qualification test within the past 12 months.

E. Fabrication: Comply with requirements of ASTM A143, ASTM A384 and ASTM A385.

F. Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

G. Construction Tolerances:
1. Variations from plumb: 1/4 inch in 10 feet.
2. Variations from level: 1/4 inch in 20 feet.
3. Variation of linear line: 1/4 inch in 20 feet.
4. Variations from slope as indicated: 1/4 inch in 10 feet.
5. Variations from flush in unit to unit offset: 1/32 inch.

1.5 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide assemblies which, when installed, comply with the following minimum requirements for structural performance without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each respective component of each metal fabrication.

1.6 SUBMITTALS

A. Manufacturer's catalog data and specification sheets for each type of manufactured product, including certification that each product complies with specified requirements. Include instructions for handling, storage, installation and protection.

B. SHOP DRAWINGS shall be provided for metal anchors, bolts, and plugs for sculpture bases, including details for connections to in place construction and sections and elevations of proposed improvements. Take all necessary field dimensions and verify dimensions as required.

C. Certificates of Compliance: Submit Certificates of Compliance from fabricator and coating manufacturer indicating compliance with requirements of specifications prior to application for payment.

D. Warranties: Submit written warranties from fabricator as follows:

1. Special Project Warranty by fabricator agreeing to repair or replace fabrications that fail in materials or workmanship due to non-compliance with specified requirements. Repair and replacement costs shall include labor, materials and overhead. Failure is defined as embrittlement, distortion, or warpage. Warranty period begins at date of fabrication and extends until 2 years after the date of Substantial Completion.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect and handle materials after fabrication in the shop, during loading, shipping, unloading at the site, storage and erection as required to prevent damage to finish surfaces, section contours, squareness, straightness and flatness of fabricated members. Use only material that is not subject to staining or discoloration for blocking and packing. Provide suitable packaging to prevent damage to surfaces and distortion of materials. For factory-primed or factory-finished materials use nylon slings or padded cables for handling.

1. Store on wood skids or pallets, covered with non-staining, waterproof membrane. Place and stack to distribute weight evenly and to prevent breakage or cracking. Protect stored materials from weather with waterproof, non-staining covers or enclosures, but allow air to circulate around materials.

1.8 PROJECT CONDITIONS

A. Field Measurements: Check by accurate field measurements before fabrication and other construction to which metal fabrications must fit. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of work.

B. Where field measurements can not be made without delaying the work, guarantee dimensions and proceed with fabrication of products without field measurements. Coordinate construction to insure that actual opening dimensions correspond to guaranteed dimensions.

PART 2 - PRODUCTS

2.1 METAL MATERIALS - GENERAL

A. Provide metal forms and types that comply with requirements of referenced standards and that are free from surface blemishes where exposed to view in the finished unit.

1. Exposed to view surfaces exhibiting pitting, seam marks, roller marks, rolled trade names, roughness, stains, discolorations or other imperfections on finished unit, and for sheet steel, variations in flatness exceeding those permitted by reference standards for stretcher-leveled sheet, are not acceptable.

B. Provide all materials of the best commercial quality for the purpose intended, free from all defects which would impair the strength or durability of the work.

C. Surface Appearance: Contractor shall be responsible for surface defects due to manufacture or fabrication of steel components. Contractor shall provide materials with acceptable appearance and smoothness, as judged solely by the Owner. Contractor shall be required to grind or blast raw materials or fabrications prior to galvanizing. Do not apply finish coatings over galvanizing until the Owner’s Representative approves surface appearance in writing.

D. Provide ferrous metals conforming to the following:

1. Steel pipe conforming to ASTM A53, type F. Standard weight shall be schedule 40 unless otherwise indicated or required.
2. Inserts:
   a. Threaded or Wedge type: galvanized ferrous castings, either malleable iron, ASTM A47, or indicated on Drawings.
   b. Provide bolts, washers, shims and miscellaneous hardware as required shall be hot dip galvanized, ASTM A153.
3. Hardware shall conform to ASTM A307 requirements.

2.4 MISCELLANEOUS MATERIALS

A. EPOXY GROUT: The non-shrink grout shall be a factory pre-mixed grout and shall conform to ASTM C1107, "Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-Shrink)." In addition, the grout manufacturer shall furnish test data from an independent laboratory indicating that the grout when placed at a fluid consistency shall achieve 95% bearing under a 4' x 4' base plate.

1. Subject to compliance with requirements, provide one of the following:

"Euco-NS":	Euclid Chemical Co.
"Five Star Grout":	U.S. Grout Corp.
"Masterflow 713":	Master Builders.

B. FINISHES: See Section 09 90 00, FINISHES, in this Specification for finish coating materials for new metal fabrications. Paint color for gate and bollards shall be black.

C. REINFORCEMENT: See Section 03 30 00, CAST IN PLACE CONCRETE, of these Specifications for reinforcing used in footings at vehicular gates.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Take field measurements prior to preparation of shop drawings and fabrication where possible. Do not delay job progress. Allow for trimming and fitting where taking field measurements before fabrication might delay work.

B. Fastening to In Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in place construction, including threaded fasteners for concrete and other connectors as required.

C. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation of miscellaneous metal fabrications. Set work accurately in location, alignment, elevation, level, true and free of rack, measured from established lines and levels.

1. Provide all temporary bracing, guy wires, turnbuckles, horizontal struts, etc., as may be required to plumb and hold the metal fabrications in place and aligned at all times during assembly and to take care of all lateral and vertical loads to which the work may be subjected. Provide temporary bracing or anchors in formwork for items which are built into concrete, masonry or similar construction.
2. Do not field modify any shop assembly unless approved by Owner’s Representative.

D. Fit exposed connections accurately together to form tight hairline joints that cannot be shop welded because of shipping size limitations. Grind exposed joints smooth.

E. Weld corners and seams continuously on all exposed surfaces and where required for strength on concealed surfaces in accordance with AWS recommendations. Tack welding will not be permitted unless specifically noted. Where flush butt joints are required, slightly oversize welds, fill with plastic filler and grind flat. Grind exposed connections smooth and flush to match and blend with adjacent surfaces.

1. Weld material: Electrodes, welding rods and filler metals are to be compatible in strength and appearance with the parent material joined.
2. Weld Preparation: Remove weld spatter by chipping or grinding. Round sharp weld edges and corners to a smooth contour by grinding. Smooth undercuts and recesses by grinding. Grind porous welds down to pinhole free metal. Remove weld flux from the surface by washing with water.

F. Field Welding: Comply with AWS Code for procedures of manual shielded metal arc welding, appearance and quality of welds made, methods used in correcting welding work and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surface matches those adjacent.

G. Install sealants in strict accordance with manufacturer's written instructions.

H. Set in sculpture bases per Section 03 30 00, CAST-IN-PLACE CONCRETE.

3.2 PROTECTION

A. Protect materials, fabrications, and assemblies with metal coatings from damage during construction using methods approved by fabricator and coating manufacturer.

END OF SECTION
05 50 00

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SECTION 26.00.00 – ELECTRICAL

PART 1 – GENERAL

1.1 DESCRIPTION

A. This section specifies requirements for electrical construction. The Electrical Contractor shall furnish, install the materials, and components required to complete all Work related to this Section.

B. All of the Contract Documents, including General and Supplementary conditions and Division 0 – Bidding Documents, Contract Forms and Conditions of the Contract and Division 1 – General Requirements, apply to the work in this Section.

C. Carefully examine all the Contract Documents for requirements which affect the work of this Section. The exact scope of this Section cannot be determined without a thorough review of all specifications sections and other Contract Documents.

D. Where referred to, Standard Specifications, Recommendations of Technical Societies, and/or Manufacturer's Associations, plus Codes of Federal, State, and Local Agencies shall include all amendments current as of date of issue of these specifications.

1.2 GENERAL

A. The General Conditions and Supplementary General Conditions of these specifications are hereby made a part of this Section.

B. Refer to drawings for further definition of location, extent, and details of work described herein.

C. Cooperate and coordinate with other trades in executing work as described in this Section.

D. Where referred to, Standard Specifications, Recommendations of Technical Societies, and/or Manufacturer's Associations, plus Codes of Federal, State, and Local Agencies shall include all amendments current as of date of issue of these specifications.

1.3 SCOPE

A. Work described herein shall be interpreted as work to be done by the Electrical Subcontractor. Work to be performed by other trades will be referenced to a particular contractor or subcontractor.

B. Provide all labor, materials, tools, and equipment, including scaffolding, to complete the installation of the electrical system. Install, equip, adjust, and put into operation the respective portions of the installation specified, and so interconnect various items or sections of work in order to form a complete and operating whole. The work shall consist of, but shall not necessarily be limited to, the following:

1. Primary conduits (concrete encasement), pole riser (per utility standards, transformer pad, grounding, bollard per utility standard, metering, etc.

2. Secondary distribution equipment and metering, Surge Protection Devices (SPD's), panelboards including feeders and sub-feeders.
3. Arc flash study.
4. Surge Protection Devices (SPD's) on all electrical panels
5. Lighting systems exterior and interior, including fixtures, lamps, time clocks, and lighting controls.
6. Coordination with the City of Worcester Closed Circuit Television (CCTV)**. Refer to the City of Worcester Request for Bids articles for additional information.**
7. All raceway systems, including boxes, couplings, and fittings.
8. All branch circuit wiring systems, including wiring devices, plates.
9. Excavation and backfill
10. Exterior box to house the electrical panel. The electrical contractor shall provide outdoor NEMA 3R stainless steel, to contain 120/240V panelboards, receptacles, etc. for power, with space for future equipment. It shall have double doors (front/back access)
11. Drilling, coring, and cutting of holes and openings
12. Scaffolding, rigging, and staging required for all electrical work.
13. Provide seismic restraints for all electrical systems and conform to Massachusetts State Building Code.
14. Signage per National Electrical Code and International Building Code
15. Any other item of work hereinafter specified or indicated on electrical drawings.

1.4 DEFINITIONS

A. Most terms used within the documents are industry standard. Certain words or phrases shall be understood to have specific meanings as follows:

1. Furnish: Purchase and deliver to a specific location within the building or site.
2. Install: With respect to equipment furnished by others, install means to receive, unpack, move into position, mount, and connect including removal of packaging materials.
3. Conduit: Raceways of the metallic type, which are not flexible. Specific types as specified.
4. Connect: To wire up, including all branch circuitry, control and disconnection devices so item is complete and ready for operation.
5. Subject to Mechanical Damage: Equipment and raceways installed exposed and less than eight feet above finished floor in mechanical rooms or other areas where heavy equipment may be in use or moved.
6. Wherever the terms "shown on drawings" are used in the specifications, they shall mean "noted", "indicated", "scheduled", "detailed", or any other diagrammatic or written reference made on the drawings.
7. Wherever the term "provide" is used in the specifications it will mean "furnish" and "install", "connect", "apply", "erect", "construct", or similar terms, unless otherwise indicated in the specifications.
8. Wherever the term "material" is used in the specifications it will mean any "product", "equipment", "device", "assembly", or "item" required under the Contract, as indicated by trade or brand name, manufacturer's name, standard specification reference or other description.
9. The terms "approved", or "approval" shall mean the written approval of the Architect.
10. The term "specification" shall mean all information contained in the bound or unbound volume, including all "Contract Documents" defined therein, except for the drawings.

11. The terms "directed", "required", "permitted", "ordered", "designated", "prescribed", and similar words shall mean the direction, requirement, permission, order, designation or prescription of the Architect; the terms "approved", "acceptable", "satisfactory", and similar words shall mean approved by, acceptable or satisfactory to the Architect; and, the terms "necessary", "responsible", "proper", "correct", and similar words shall mean necessary, reasonable, proper or correct in the judgment of the Architect.
12. "Concealed" means hidden from sight in chases, furred spaces, shafts, hung ceilings, embedded in construction or in crawl spaces.
13. "Exposed" means not installed underground or "concealed" as defined above.
14. "The Subcontractor" shall refer to the "Electrical Subcontractor" responsible for all work under the Electrical Section of these specifications, as applicable and as defined under Supplementary General Conditions and other Sections of these specifications. It is the intent of these specifications that the Electrical Subcontractor and his Sub-Subcontractors shall be responsible for furnishing and installation of all work indicated on the Electrical Contract Drawings and Specifications, and all related or implied work specified in other Sections of these specifications, as such information and requirements relate to the Electrical Trade.

1.5 RELATED WORK

A. The following related work is to be performed under designated sections.

1. **City of Worcester Request for Bids articles for additional information.**
2. Excavation and Backfill: SECTION 31.00.00, EARTH WORK (except within building foundation).
3. Concrete Bases, Pads, and Duct Envelopes: DIVISION 03.00.00, CAST IN PLACE CONCRETE.
4. Patching: To be done by trade responsible for surface requiring patching.
5. Payment for energy for temporary light and power shall be made by General Contractor.

1.6 CONTRACT COST BREAKDOWN

A. The following related work is to be performed under designated sections.

1.7 INSPECTION OF SITE

A. It is optional, for the Electrical bidders to inspect site. Failure to inspect existing conditions or to fully understand work which is required shall not excuse Electrical Subcontractor from his obligations to supply and install work in accordance with specifications and the drawings and under all site conditions, as they exist.

1.8 CONTRACTOR'S REPRESENTATIVE

A. Retain a competent representative on the project.

1.9 COOPERATION

A. Work shall be carried on under usual construction conditions, in conjunction with other contractors work. Cooperate with other contractors, coordinate work, and proceed in a manner as not to delay progress.

B. Before proceeding, examine all construction drawings and consult other contractors to coordinate installation and avoid interference.

C. In case of dispute, the Architect will render a decision in accordance with General and Supplementary General Conditions.

1.10 CODES, ORDINANCES, AND PERMITS

A. Codes and Ordinances

1. All material and work provided shall be in accordance with the following codes and standards as most recently amended.

NFPA -70 "*National Electrical Code*", 2023 Edition
Massachusetts Electric Code Amendments, 2023 Edition
Commonwealth of Massachusetts State Building Code, 9th Edition
International Building Code (IBC), 2015 Edition
State Department of Public Safety
Standards of the Underwriters Laboratories (UL)
Occupational Safety and Health Act (OSHA)
Americans with Disabilities Act (ADA)
Energy Conservation Code
International Energy Conservation Code (IECC), 2015 Edition
City of Worcester

2. Where contract documents indicate more stringent requirements than codes, the contract documents shall take precedence.

B. Permits: Be responsible for filing documents, payment of fees, and securing of inspection and approvals. Local housing authority will reimburse electrical contractor for all permit fees.

1.11 ELECTRICAL ROOMS OR SPACES

A. Be responsible for ensuring that the dedicated space and clearances required in the NEC, Article 110.26 is maintained for all electrical equipment.

B. Call other contractors' attention to the requirements contained in the above mentioned code sections, prior to the installation of equipment by other contractors, in order to ensure no violations.

1.12 SUBMITTALS

A. Refer to Supplementary General Conditions for information relative to submission of shop drawings. No equipment for which review is required shall be installed prior to review,

except at Contractor's own risk. Shop Drawings will be required for all electrical equipment.

B. Notwithstanding any restrictions upon contractor proposed substitutions, should apparatus or materials be permitted by Architect to be substituted for those specified for good cause, and such substitution necessitates changes in or additional connections, piping, supports, or construction, same shall be provided. Assume cost and entire responsibility thereof.

C. Submit the following samples:

1. Lighting fixtures other than specified item.
2. Other items as may be requested.

1.13 GUARANTEE

A. Keep work in repair without expense to Owner as far as concerns defects in workmanship or materials for a period of not less than one year from date of substantial completion.

1.14 INSPECTIONS AND TESTS

A. Inspection: If inspection of materials installed shows defects, such defective work, materials, and/or equipment shall be replaced and inspection and tests repeated.

B. Tests: Make reasonable tests and prove integrity of work and leave electrical installation in correct adjustment and ready to operate. All panels and switchboards shall have phases balanced as near as practical. A consistent phase orientation shall be adhered to at all terminations.

PART 2 - PRODUCTS

2.1 GENERAL

A. Product specifications are written in such a manner so as to specify what materials may be used in a particular location or application and therefore do not indicate what is not acceptable or suitable for a particular location or application. As an example: non-metallic sheathed cable is not specified; therefore, it is not acceptable.

B. For purpose of establishing a standard of quality and not for purpose of limiting competition, the basis of this Specification is upon specified models and types of equipment and materials, as manufactured by specified manufacturers.

C. In all cases, standard cataloged materials and systems have been selected. Materials such as lighting fixtures specially manufactured for this particular project and not part of a manufacturers' standard product line will not be acceptable. In the case of systems, the system components shall be from a single source regularly engaged in supplying such systems. A proposed system made up of a collection of various manufacturers' products will be unacceptable.

D. Where Specifications list manufacturers' names and/or "as approved" or "Equal approved by Architect", other manufacturers' equipment will be considered if equipment meets Specification requirements and has all features of the specified items as are considered essential by Architect.

E. All material shall be new and shall be UL listed.

2.2 RACEWAYS AND FITTINGS

A. Raceways - General

1. No raceway shall be used smaller than 1/2" diameter and shall have no more than four (4) 90° bends in any one run, and where necessary, pull boxes shall be provided. Only rigid metal conduit or intermediate metal conduit is allowed for slab work. Cable systems, if allowed to be used by other sections of this specification, shall not be used exposed or in slabs, whether listed by "UL" for such use or not.
2. Rigid metal conduit conforming to, and installed in accordance with, Article 344 shall be heavy wall zinc coated steel conforming to American Standard Specification C80 1 and may be used for service work, exterior work, slab work, and below grade level slab, wet locations, where raceway may be subject to mechanical damage.

b. Design and Performance Requirements

1) Condulet Bodies shall be dust-tight. Certified to UL50E
2) Condulet Bodies shall be NEMA 3R raintight when installed with a cover and gasket.
3) Conduit bodies when Iron made shall be protected with a three coat finish consisting of cadium, zinc and aluminum acrylic paint
4) Conduit bodies shall have a rounded bottom that helps prevent the snagging of fish wire
5) Conduit bodies when Iron made shall be able to be removed from an installation by cracking with a hammer

3. Intermediate Metal Conduit (IMC) conforming to, and installed in accordance with, Article 342, may be used for all applications where rigid metal conduit is allowed by these specifications.
4. Electrical Metallic Tubing (EMT), conforming to, and installed in accordance with, Article 358 shall be zinc coated steel, conforming to industry standards, may be used in masonry block walls, stud partitions, above furred ceilings, where exposed but not subject to mechanical damage, and shall be used for fire alarm work.
5. Flexible metal conduit shall be used for final connections to recessed lighting fixtures from above ceiling junction boxes and for final flexible connections to motors and other rotating or vibrating equipment. Liquid tight flexible metal conduit shall be used for the above connections which are located in moist locations. All flexible connections shall include an insulated grounding conductor.
6. Rigid non-metallic conduit may be used at the contractor’s option for underground electric and low tension services outside the foundation wall and shall be Polyvinyl Chloride (PVC) schedule 40, 90ºC.
7. Rigid non-metallic conduits shall be polyvinyl chloride (PVC) schedule 80, 90°C (thick wall) conforming to and installed in accordance with ARTICLE 352, may be

used below slab within the foundation wall and underground outside the foundation wall.

8. Acceptable manufacturers:

   Robroy Industries
   Republic Conduit
   Youngstown Tube Company
   Carlon
   Allied Tube and Conduit

9. Fittings

   a. Provide insulated bushings on all raceways 1-inch diameter or larger.
   b. Manufacturer's standard fittings shall be used for raceway supports.
   c. Expansion Fittings: Expansion fittings shall be used where structural and concrete expansion joints occur and shall include a ground strap.
   d. PVC expansion fittings shall be used where it is expected to be more than a ¼" or greater in a straight run between securely mounted items such as boxes, cabinets, elbows or other conduit termination. Comply with table 352.44 for expansion characteristics for PVC conduits.
   e. Couplings for rigid metal and intermediate metal conduit shall be threaded type.
   f. Threadless fittings for EMT shall be watertight compression type (wet locations) or set screw type (dry locations). All fittings shall be concrete tight. No diecast fittings allowed except for raceways larger than 1-inch diameter.
   g. Cable supports in vertical raceways shall be of the split wedge type. Armored cable supports for vertical runs to be of wire mesh basket design.
   h. Wall entrance seals shall be equal to O.Z. Gedney type "WSK".
   i. Couplings, elbows and other fittings used with rigid nonmetallic conduit shall be of the solvent cemented type to secure a waterproof installation.
   j. Acceptable manufacturers:
      O.Z.
      Crouse Hinds
      Appleton
      EFCOR
      Steel City

B. Outlets, Pull and Junction Boxes

1. Outlets

   a. Each outlet in wiring or raceway systems shall be provided with an outlet box to suit conditions encountered. Boxes installed in normally wet locations or surface mounted shall be of the cast metal type having hubs. Concealed boxes shall be cadmium plated or zinc coated sheet metal type. Old work boxes with Madison clamps not allowed in new construction. Thru the wall boxes are not permitted.
   b. Each box shall have sufficient volume to accommodate number of conductors in accordance with requirements of Code. Boxes shall not be less than 1 1/2" deep unless shallower boxes are required by structural conditions and are specifically approved by Architect. Ceiling and bracket outlet boxes shall not be less than 4" octagonal except that smaller boxes may be used where required by particular fixture to be

installed. Flush or recessed fixtures shall be provided with separate junction boxes when required by fixture terminal temperature requirements. Switch and receptacle boxes shall be 4" square or of comparable volume.

c. Far side box supports shall be Caddy J 1A.

d. Acceptable manufacturers:
Appleton
Crouse Hinds
Steel City
RACO

2. Pull and Junction Boxes

a. Where indicated on plans, and where necessary to terminate, tap off, or redirect multiple raceway runs or to facilitate conductor installation, furnish, and install appropriately designed boxes. Boxes shall be fabricated from code gauge steel assembled with corrosion resistant machine screws. Box size shall be as required by Code.

b. Boxes in moist or wet areas shall be galvanized type. Boxes larger than 4 11/16 inches square shall have hinged covers. Boxes larger than 12 inches in one dimension will be allowed to have screw fastened covers, if a hinged cover would not be capable of being opened a full 90 degrees due to installation location.

c. Acceptable Manufacturers:

Hoffman
Keystone
Lee Products Co.

2.3 CONDUCTORS

A. All conductors shall be a minimum size of #12 AWG except for control wiring and fire alarm wiring where #14 AWG may be used. For all exit sign circuits, normal/emergency and/or emergency only circuits, exterior lighting circuits, and also where distance from panelboard to first outlet exceeds 80', #10 AWG shall be minimum size wire allowed. All feeder and branch circuit conductor shall be color coded as follows:

1.	208Y/120V	Phase A	Black
2.	208Y/120V	Phase B	Red
3.	208Y/120V	Phase C	Blue
4.	Grounded Conductor	120/208	White
5.	Equipment Ground	120/208	Green

B. All conductors not installed in accordance with color scheme shall be replaced. All conductors larger than #6 AWG must be identified with colored tape.

C. Connections throughout the entire job shall be made with solderless type devices.

1. For #10 AWG and smaller: spring type.
2. For #8 AWG and larger: circumferential compression type.
3. Acceptable manufacturers:
3M "Scotchlock"
IDEAL "Wingnut"
BURNDY

4. Any splices made up in ground mounted pull boxes shall be resin cast waterproof type or waterproof pressure type, as manufactured by King Technology, St. Louis, MO.

D. Conductors shall be copper, soft drawn, and annealed of 98% conductivity. Conductors larger than #10 AWG shall be stranded; #10 AWG and smaller shall be solid. Conductors shall be insulated for 600 volts and be of following types:

1. All conductors shall have heat/moisture resistant thermoplastic insulation type THHN/THWN (75°C) except as follows:

a. In sizes #1 AWG and larger: Crosslinked polyethylene insulation type XHHW (75°C, 90°C) may be used.

E. Stranded conductors for all wiring systems except fire alarm will be allowed if installed and terminated as specified under Execution Section.

F. Acceptable manufacturers:

South Wire
American Flexible Conduit (AFC) Company
American Wire & Cable
Superior Essex
Okonite

2.4 SLEEVES, INSERTS, AND OPENINGS

A. Sleeves: Provide sleeves of proper sizes for all openings required in concrete floors and walls. Sleeves passing through floors shall be set with top of sleeve 1" above finished floor. Core drilling will also be acceptable if in accordance with any structural standards. Any un-sleeved openings shall be waterproofed.

B. Inserts: Provide inserts or other anchoring devices in concrete and masonry construction as required to support raceways and equipment.

C. Openings: Where an opening is required in concrete slabs to allow passage of a multitude of raceways, give adequate notice to General Contractor so he may box out opening in form work.

D. Sleeves or openings through slabs for passage of future cables shall be located within 6 inches of walls and shall be in a single row and shall be proofed whether used or not.

E. Any openings through fire rated surfaces shall be closed off with fireproofing materials providing the same rating as the surface penetrated.

F. Any openings through concrete foundation walls shall be closed off with waterproofing materials providing the same rating as the surface penetrated. Pipe/conduit sleeves shall be equal to Emerson – WSK series seals.

G. Acceptable Manufacturers:

Specified Technologies Inc.
Thomas & Betts
3M Fire Protection Products

Dow Corning

2.5 WIRING DEVICES

A. Receptacles: Receptacles shall be flush mounted. All devices to be of same manufacturer.

Acceptable Manufacturers:
Tamper Resistant

Twenty (20) ampere ground fault interrupter, grounding type NEMA 5 20R, Weather Resistant
Cooper TWRVGF20
Pass and Seymour 2095TRW
Leviton W7899-TRE

B. Toggle Switches:

Toggle Switches: Shall be totally enclosed tumbler type with bodies of phenolic compound. Toggle handles shall be ivory in color unless otherwise specified. The rocker type switch is not acceptable and will not be approved.

1. Switches installed in hazardous areas shall be explosion proof type in accordance with the NEC and as shown on the drawings.

2. Shall be single unit toggle, butt contact, quiet AC type, heavy duty general-purpose use with an integral self-grounding mounting strap with break-off plasters ears and provisions for back wiring with separate metal wiring clamps and side wiring with captively held binding screws.

3. Ratings:

a. 120 volt circuits: 20 amperes at 120-277 volts AC.
b. 277 volt circuits: 20 amperes at 120-277 volts AC.

2. Manufacturers:

Hubbell 1221,
Pass and Seymour 20AC 2,
Leviton 1221.
Prewired devices with pigtails acceptable

C. Composition material of wiring devices to be nylon with ivory finish.

D. Cover plates

1. Provide gaskets on all wiring device plates where devices are on walls separating conditioned and non-conditioned spaces.
2. On residential projects. Use weather-proof bell box with in-use cover
3. On commercial projects Extra-Duty box/covers shall be used per NEC 406.9(B)(1).

2.6 LIGHTING FIXTURES

A. Provide lighting fixtures complete with lamps, ballasts, and other devices as required for a first class installation.

B. All specialized lamps to be of a type recommended by the fixture manufacturers in their photometric reports.

C. Exterior LED sources shall meet the following requirements:
1. Operating temperature rating shall be between -40°F [-40°C] and 120°F [50°C].
2. Color Rendering Index (CRI): ≥65.
3. The manufacturer shall have performed JEDEC (Joint Electron Devices Engineering Council) reliability tests on the LEDs as follows: High Temperature Operating Life (HTOL), Room Temperature Operating Life (RTOL), Low Temperature Operating Life (LTOL), Powered Temperature Cycle (PTMCL), Non-Operating Thermal Shock (TMSK), Mechanical Shock Variable Vibration Frequency, and Solder Heat Resistance (SHR).

D. Fixture types shall be as scheduled. The note on fixture schedule “Possibly Acceptable Alternate Manufacturers” means that the manufacturers listed have products which could be equal. The determination of “equal” will be determined based upon features of the product specified by catalog number. A sample of any proposed substitution will be required. Standard cataloged products have been selected. Fixtures specially manufactured for this particular project and not part of a manufacturer’s standard line will not be acceptable.

2.7 GROUNDING SYSTEM

A. All equipment and systems shall be grounded. Refer especially to NEC Article 250.52 Requiring Connections to Building Steel, Foundation, Water Service, and Interior Piping. Provide transformer pad grounding to be in accordance with utility company standards.

B. The grounded conductor shall be supplemented by an equipment grounding system.

C. The equipment grounding system shall be installed so all conductive items in close proximity to electrical circuits operate continuously at ground potential and provide a low impedance path for ground fault currents.

D. Grounding conductors shall be so installed as to permit shortest and most direct path to ground.

E. Maximum measured resistance to ground of 25.0 ohms shall not be exceeded (NFPA 70-, Article 250.53(A)(2)).

F. Equipment grounding conductors and straps shall be sized in compliance with Code Table 250.122.

G. Grounding conductors shall be insulated with green color. Grounding conductors for use on isolated ground receptacles shall be green with trace color to differentiate between normal ground conductors.

H. Branch circuits shall consist of phase and grounded conductor installed in common metallic raceway. The raceway system may not serve as the grounding conductor. All circuits shall have a separate insulated grounding conductor installed. Any flexible cable

system or non-metallic raceway system shall have an insulated grounding conductor. Any cable system for use on isolated ground circuits shall have both an isolated ground conductor as well as an equipment ground conductor, both of which shall be insulated.

I. Each electrical expansion fitting shall be furnished with a bonding jumper. Provide grounding bushings and ground connections for all raceways terminating below equipment where there is no metal to metal continuity.

J. Continuity between all metallic and non-metallic raceway systems and equipment shall be maintained.

K. Outdoor lighting fixtures shall be grounded and bonded in common with building system via a separate grounding conductor.

L. Pad-Mounted Transformers:

1. Provide a driven ground rod and bond with a grounding electrode conductor to the transformer grounding pad.
2. Ground the secondary neutral.

M. Grounding Equipment

1. Ground Rods

a. Copper clad steel19 mm (0.75 inch) diameter by 3 M (10 feet) long.
b. Quantity of rods shall be as shown on the drawings, and as required to obtain the specified ground resistance.

2. Concrete Encased Electrode

a. Concrete encased electrode shall be No. 4 AWG bare copper wire, installed per NEC.

3. Ground Connections

a. Below Grade and Inaccessible Locations: Exothermic-welded type connectors.
b. Above Grade:

1) Bonding Jumpers: Listed for use with aluminum and copper conductors. For wire sizes No. 8 AWG and larger, use compression-type connectors. For wire sizes smaller than No. 8 AWG, use mechanical type lugs. Connectors or lugs shall use cadmium-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.
2) steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

2.8 PANELBOARDS

A. Panelboards shall be as shown on the drawings. Refer to drawings for details regarding location of components, voltage and current rating of devices and other required details. Suitable for use as Service Entrance given compliance with NEC.

B. Lighting And Power Distribution Panels (Standard)

1. Furnish Siemens Industry Lighting Panelboards, Type P1.

2. NEMA PB 1, circuit breaker type.

a. Standard Lighting and Power Distribution

1) Main Lug Panels to be rated as indicated on the drawings. Main lugs shall be either removable or lay-in style construction for panels up to 250 amps to facilitate connections.
2) Main circuit breaker panels to be rated as indicated on the drawings.

3. Standard lighting and power distribution panels (P1) shall be field convertible from Main Lug to Main Breaker with no increase in panel height. Field- addable mains (bussed connected) sub-feed breaker or feed-thru lug kits shall also be available, without utilizing any branch circuit space.

4. Interior shall be changeable from top to bottom feed and vice-versa, while maintaining readability of dead- front labeling on standard lighting and power distribution panels.

C. Lighting and Power Distribution (Custom) for applications requiring bus connected RC switches, split bus, special bussing size or material, special wire connectors and other than standard size enclosures or voltages or systems.

1. Furnish Siemens Industry Series Lighting Panelboards, Type P2.

2. NEMA PB 1, circuit breaker type.

a. Custom Lighting and Power Distribution

1) Main Lug Panels to be rated as indicated on the drawings.
2) Main Circuit Breaker panels to be rated as indicated on the drawings.

D. Bussing

1. Copper sized in accordance with UL 67 standards for temperature rise.

E. Ground Bars

1. A copper equipment ground bar shall be provided.

F. Neutrals

1. Neutral bussing shall have a lug for each outgoing branch requiring a neutral connection; P1 and P3 load side neutral connection lugs to be split with each side taking 50% of load neutral connections.

G. Enclosure

1. Boxes shall be fabricated from galvanized, galvaneal steel or protected against corrosion per the requirements of NEMA 250, UL 50 and UL50E. Box or panel

interior shall have adjustable screws to provide easy alignment for flush mounted applications. Removable end walls to be with KO's.

2. Surfaces of the trim shall be properly cleaned and painted gray ANSI 61.

H. Trims

1. Trims for Lighting and Power distribution shall be as indicated on the drawings. It shall be fabricated from steel, painted with an ANSI-61 light gray finish and equipped with concealed hinges, flush lock and circuit directory cardholder. Trim shall have two separate supports designed to engage the box flange to stabilize and secure the trim during installation. Trim screws to be located behind the lockable door for tamper resistance. Optional trims may be hinged to the box, door in door.

2. Trims for Distribution Panels shall be as indicated on the drawings. It shall be fabricated from steel, painted with an ANSI-61 light gray finish. Optional trims may be hinged to the box, door in door.

I. Circuit Breakers

1. Molded case circuit breakers shall be bolt-on devices. Short circuit rating shall be amperes symmetrical based on the smallest rating on any circuit breaker installed in the panel and as shown on the drawings, but not less than 10kaic at 240 VAC. Molded case circuit breaker shall be of the quick-make, quick-break, trip-free, thermal magnetic type.
2. Molded case circuit breakers shall be thermal-magnetic, quick-make, quick-break, trip free. Multi-pole breakers shall be common trip.
3. Provide circuit breaker accessories as indicated on the drawings or panel schedules.
4. Provide SWD rated breakers for all lighting branch circuits and UL Listed Type HACR for all air conditioning equipment branch breakers.

J. Surge Protection Device

1. If indicated on drawings, a SPD - Surge Protection Device shall be installed with a direct bus connection for low clamping and without utilizing any circuit breaker positions. It shall be listed in accordance with UL 67, 1283 and 1449. Designed and tested in accordance with ANSI/IEEE C62.45 and C62.41.

    a. Surge capacity shall be 100kA per phase Lighting Panelboards, Type [P1] [P2].
    b. Field-addable, bolt-on connection, into existing P1 lighting panels with UL 1449 listing.
    c. Factory installed SPD units shall be available for mounting in unit space in distribution panels type P4 and P5.
    d. 5 year warranty with LED indicators for immediate status monitoring. Audible alarm with silencing switch and test button.

K. Arc Flash

1. Provide a complete arc flash study of the entire electrical system from the point of incoming service to all panelboards. Labels shall include the arc flash boundary in feet, hazard category and a list of appropriate PPE.

2.9 ELECTRICITY METERING, SINGLE SOCKET

A. The meter socket devices shall have individual covers of ringless style design. Meter sockets shall have a barrel-locking, padlocking, wire hasp or other sealing provision.

B. The sockets shall be rated 200 amps continuous. Up to 300 volts at 3 phase, 4 wire].

C. All current carrying parts shall be tin plated or equivalent to resist corrosion. All lugs shall be the extruded aluminum lay-in type design and shall be suitable for use with 60/75 degree C copper or aluminum wire.

D. Line side meter jaws for non-lever-bypass sockets shall have meter guides and all meter jaws shall be made from copper alloy. Non lever bypass socket jaws shall be spring reinforced mounted to a special thermoset insulating block.

E. Switch Enclosures

1. The single position meter sockets shall be continuous duty rated. Outdoor enclosures shall be fabricated from zinc-coated steel finish or 3003 grade aluminum [with] [without] an ANSI light gray paint applied by electro-deposition process.

F. Factory Testing

1. Standard factory tests shall be performed on the equipment in accordance with the latest version of applicable NEMA and UL standards.

G. Arc Flash

2. Provide a complete arc flash study of the entire electrical system from the point of incoming service to all panelboards rated 240V at 10 kaic or greater. Labels shall include the arc flash boundary in feet, hazard category and a list of appropriate PPE.

2.10 ELECTRIC SERVICE

A. Coordinate and cooperate with National Grid Company, hereinafter called utility company, with respect to providing service and metering. See allowances section for back charges by utility company with respect to permanent service.

B. Provide all primary system raceways, elbows, pull wires and all pad grounding. Utility company will provide pad-mounted transformers, primary switches, and primary conductors including making up of all terminations and connections.

C. Provide secondary service complete including all conductors, raceways, and connectors at transformer. Provide oversize lugs if required due to conductor sizing. Attachment of secondary conductors to the transformer terminals will be done by utility company.

D. General Contractor shall do all excavation and back filling (in accordance with utility company standards) and shall construct the reinforced concrete pads for transformers.

E. All work to be done in accordance with utility company standards.

F. Metering: All usage will be on one secondary meter. Utility Company will furnish current transformers and potential transformers to be installed in switchboard by contractor. Empty raceway with pull wire from the C/T compartment to the meter backboard shall be provided.

2.11 UNDERGROUND DUCTBANKS

A. General: Furnish and install the ductbanks and extension of existing as herein specified and as shown on the drawings.

B. Division of Work:

1. The General Contractor shall be responsible for the work and material required for the following:

   a. Excavation
   b. Backfill
   c. Concrete envelope for conduits including reinforcing rods and tie down rods.
   d. Brick or concrete collars to bring manhole frames and covers up to grade. Installation of frames and collars, which are to be furnished by the Electrical Subcontractor.

2. All other material, equipment, and labor required for the complete ductbank extension shall be furnished and installed by the Electric Subcontractor under this Section, including the following:

   a. Service raceways.
   b. Grounding material.
   c. Detectable Ductbank warning tape. Equal to Ideal model, 42-251
   d. Pre-cast manholes.

C. Materials

1. Conduit: Type Schedule 40 PVC where installed in concrete envelope. See BASIC MATERIALS SECTION.
2. Conduit Supports (duct system): Shall be molded plastic with interlocking lugs and skeletonized structure, minimum separation 3”.
3. Tags: Non-ferrous metal or fiber, ¼” high letters.
4. Detectable Warning tape shall be solid aluminum foil, 6” wide, as manufactured by Ideal Industries, and shall be installed above all ductbanks both high and low tension.

D. Duct System

1. The duct system shall consist of Schedule 40 PVC conduit encased in concrete except where otherwise specified. The size and number of conduits shall be as indicated on the drawings. Provide a pull wire in each conduit.
2. The entire length between manholes and end of ductbank shall be excavated and graded before any conduit is laid.
3. The ductbank shall be set on undisturbed earth.
4. The conduit shall be installed so that top of concrete is a minimum of 36” below finished grade unless otherwise indicated, and shall be laid to a minimum grade of 4” for each 100 feet of length. Duct system shall drain to manholes.

5. Changes in direction shall be made by long sweep bends, minimum radius 25 feet except that at the end of a run, within 10 feet of termination. Manufactured ends may be used having a minimum radius of 48 inches.
6. Conduit base and intermediate spacers shall be installed a maximum of 5 feet on centers. Spacers shall not be placed one above the other, but shall be staggered a minimum of 6".
7. All conduit joints shall be made watertight by means of a sealing compound before the coupling is installed. Joints in conduit shall be staggered, minimum space between joints in adjacent conduit shall be 6".
8. When the required number of conduits has been installed, securely tie the assembly together at distances not exceeding 7 feet. Tie shall consist of three (3) turns of No. 18 iron wire. Separate ties required for low tension and high tension conduit runs.
9. Duct envelope shall be of monolithic construction and shall be vibrated to eliminate voids.
10. Pouring of concrete shall be continuous throughout the length of construction. The end of the pour shall be interlocked or sloped. If the installation is halted, the ends of conduit shall be plugged.
11. Concrete shall not be poured until the conduit installation has been observed by the Architect.
12. Detectable Warning tape shall be installed during backfilling and shall be placed approximately 12" above the concrete encasement.
13. After the installation in completed, each conduit shall be cleaned and identified. A standard flexible mandrel and a stiff bristle brush shall be pulled through each conduit. The mandrel shall not be less than 12" long and the diameter approximately ¼" less than the conduit.
14. Manholes shall be furnished and installed by electrical Subcontractor. Provide frames and covers as indicated on the drawings.

2.12 OUTDOOR NEMA 3R STAINLESS STEEL CABINET

A. The Contractor shall provide outdoor NEMA 3R stainless steel, to contain 120/240V panelboards, receptacles, etc. for power, with space for future equipment.

B. Contractor shall size cabinet to coordinate with sizes of panelboard and equipment to be installed within cabinets. Dimensions shown are typical and are for reference only. Cabinet shall be similar to cabinets installed at the recently renovated Parks (list provided upon request). Cabinet shall include all equipment shown or implied and all equipment shall be installed inside of cabinet without physical conflicts and per NEC, Cabinet shall be sized for all necessary conduits, whether active, spare or future as listed on panelboard schedules.

C. Cabinets shall be manufactured from 12 gauge minimum stainless steel, painted black with 12 gauge steel panel, mounted inside. Cabinets to have integral keyed locking mechanism, keyed alike, with provision for pad-lock. Cabinets shall be ventilated type and factory painted black powder-coat. Cabinets shall have door hold-open latches.

PART 3 - EXECUTION

3.1 WORK COORDINATION AND JOB OPERATIONS

D. Equipment shall not be installed in congested and possible problem areas without first coordinating installation of same with other trades. Relocate electrical equipment installed in congested or problem areas should it interfere with the proper installation of equipment to be installed by other trades.

E. Particular attention shall be directed to coordination of lighting fixtures and other electrically operated equipment requiring access which is to be installed in ceiling areas. Coordinate with other trades, the elevations of equipment in hung ceiling areas to insure adequate space for installation of recessed fixtures before said equipment is installed. Conflicts in mounting heights and clearances above hung ceilings for installation of recessed lighting fixtures or other electrically operated equipment requiring access shall be brought to the attention of Architect for a decision prior to equipment installation.

F. Furnish to General Contractor and other subcontractors information relative to portions of electrical installation that will affect other trades sufficiently in advance so that they may plan their work and installation.

G. Obtain from other trades information relative to electrical work which he, the Electrical Subcontractor, is to execute in conjunction with installation of other trades' equipment.

H. Lighting fixtures in mechanical spaces or utility/ storage rooms shall only be installed after all mechanical equipment is in place.

3.2 PLANS AND SPECIFICATIONS

A. Plans:

1. Drawings showing layout of electrical systems indicate approximate location of raceways, outlets and apparatus. Runs of feeders and branch circuits are schematic and are not intended to show exact routing. Final determination as to routing shall be governed by structural conditions and other obstructions.

B. Specifications:

1. Specifications supplement drawings and provide specifics pertaining to methods and material to be used.

3.3 IDENTIFICATION

A. Equipment shall be marked for ease of identification as follows.

1. Provide screw on nameplates on switchboards, panel boards, F.A. terminal cabinets, starters, and disconnect switches. Nameplates to be of black phenolic with white engraving. For starters and disconnect switches lettering shall be minimum of 1/4" high. Nameplates on panel boards shall have the following information.

a. ***Line 1 - Panel designation in 1/2" high letters.***
b. ***Line 2 - Utilization voltage in 3/8" high letters.***
c. ***Line 3 - Distribution source "Fed from ____" in 1/4" high letters.***

d. ***Provide screw on nameplate for available fault current of the electrical service in accordance to NEC 110-24. Provide the voltage, available short circuit current along with the date of the installation.***

e. Neatly typed directory cards listing circuit designations shall be fastened inside the cover of panel boards. Spare circuits shall be penciled.

f. Color coding schedules. If there is more than a single system voltage, different voltages shall have secondary switchboard and distribution panel and shall be of the phenolic nameplate type as previously specified. A typewritten color code schedule shall also be affixed, under plastic, inside each panel board door.

g. Outlet boxes both concealed and exposed shall be identified as to panel origination and circuit number by means of fibre pen on the inside of cover plate.

3.4 PROTECTION AND CLEANUP

A. Protection

1. Materials and equipment shall be suitably stored and protected from weather.

a. During progress of work, pipe and equipment openings shall be temporarily closed so as to prevent obstruction and damage.

b. Be responsible for maintenance and protection of material and equipment until final acceptance.

B. Cleanup

1. Keep job site free from accumulation of waste material and rubbish. Remove all rubbish, construction equipment, and surplus materials from site and leave premises in a clean condition.

a. At completion, equipment with factory finished surfaces shall be cleaned and damaged spots touched up with the same type paint applied at factory.

b. Particular attention is called to Article 110 12(c) of the NEC, which requires that internal parts of electrical equipment not be contaminated by construction operations.

3.5 PORTABLE OR DETACHABLE PARTS

A. Retain possession of and be responsible for spare parts, portable and detachable parts, and other removable portions of installation including fuses, keys, locks, blocking clips, inserts, lamps, instructions, drawings, and other devices or materials that are relative to and necessary for proper operation and maintenance of the system until final acceptance, at which time such parts shall be installed or turned over to the Owner, as the case may be.

3.6 SAFETY PRECAUTIONS

A. Provide proper guards, signage, and other necessary construction required for prevention of accidents and to insure safety of life and property. Remove any temporary safety precautions at completion.

3.7 MOUNTING HEIGHTS

A. All electrical equipment shall be mounted at the following heights unless noted or detailed otherwise on drawings. Notes on architectural drawings shall supersede those noted below or detailed on the electrical drawings. If mounting height of an electrical component is questionable, obtain clarification from Architect before installation.

1. Duplex convenience outlets, microphone outlets, and telephone outlets - 18 inches.

a. Light switches, pushbutton stations, HOA switches, and all other toggle or control switches for the operation of heating, ventilating, and air conditioning, plumbing, and general service - 48 inches.
b. Panelboards for lighting, power, telephone, and other auxiliary systems - 78" to top.
c. Exterior and interior wall brackets shall be as detailed on architectural drawings or as directed by Architect.

B. Mounting heights given are from finished floor to centerline. In the case of a raised floor, surface of raised floor is the finished floor.

3.8 WORKMANSHIP AND INSTALLATION METHODS

A. Work shall be installed in first class manner consistent with best current trade practices. Equipment shall be securely installed plumb and/or level. Flush mounted outlet boxes shall have front edge flush with finished wall surface. No electrical equipment shall be supported by work of other trades. Cable systems shall be supported and not draped over ducts and piping or laid on ceiling suspension members. Lighting fixtures shall be installed to agree with Architects reflected ceiling plans.

B. Supports

1. Support work in accordance with best industry practice and by use of standard fittings.
2. In general, walls and partitions will not be suitable for supporting weight of panelboards, dry type transformers and the like. Provide supporting frames or racks extending from floor slab to structure above.
3. Provide supporting frames or racks for equipment, intended for vertical surface mounting in free standing position where no walls exist.
4. Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members, rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workmanlike arrangement of equipment.
5. Provide 3/4" thick painted plywood mounting surfaces in all electric and telephone areas and for all equipment on free standing racks. All plywood shall be fire retardant and painted both sides and edges with 2 coats of white paint.
6. No work for exposed installations in damp locations shall be mounted directly on any building surface. In such locations, flat bar members or spacers shall be used to create a minimum of 1/4" air space between building surfaces and work.
7. Nothing (including outlet, pull and junction boxes and fittings) shall depend on electric raceways or cables for support. All outlet, pull, and junction boxes shall be independently supported.
8. Nothing shall rest on, or depend for support on, suspended ceiling or its mounting members.

9. Support surface or pendant mounted lighting fixtures:
10. From outlet box by means of an interposed metal strap, where weight is less than five pounds.
11. From outlet box by means of a hickey or other direct threaded connection, where weight is from five to fifty pounds.
12. Directly from structural slab, deck or framing member, where weight exceeds fifty pounds.
13. Pendant lighting fixtures shall be supported by threaded rods in non-public areas and by manufacturers standard tube hangers with swivel aligner and canopy in public areas. Provide nonstandard pendant lengths where required to mount fixtures at elevations either called for on drawings or as shown in architectural elevations.
14. Support recessed lighting fixtures directly from structural slabs, decks or framing members, by means of jack chain or air craft cable, one at each end of fixture at opposite corners.
15. Where support members must of necessity penetrate air ducts, provide airtight sealing provisions which allow for a relative movement between the support members and the duct walls.
16. Provide channel sills or skids for leveling and support of all floor mounted electrical equipment.
17. Where permitted loading is exceeded by direct application of electrical equipment to a slab or deck, provide proper dunnage as required to distribute the weight in a safe manner.
18. Support metallic raceways by either running within steel frame or hung from the building frame. Anything hung from building frame shall be attached with metallic fasteners.

C. Fastenings

1. Fasten electric work to building structure in accordance with the best industry practice.

    a. Where weight applied to attachment points is 100 pounds or less, fasten to building elements of:
    b. Wood - with wood screws.
    c. Concrete and solid masonry - with bolts and expansion shields.
    d. Hollow construction - with toggle bolts.
    e. Solid metal - with machine screws in tapped holes or with welded studs.
    f. Where weight applied to attachment points exceeds 100 pounds, fasten as follows:
        1. At field poured concrete slabs, provide inserts with 18" minimum length slip through steel rods, set transverse to reinforcing steel.
        2. Where building is steel framed, utilize suitable auxiliary channel or angle iron bridging between structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.
    g. Floor mounted equipment shall not be held in place solely by its own dead weight. Provide floor anchor fastenings. Floor mounted equipment over 72 inches in height shall also be braced to nearest wall or overhead structural elements.
    h. For items which are shown as being mounted at locations where fastenings to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging to building structural elements.

i. Fastenings for metallic raceways using the fastening as support shall be of the metallic type. Fastenings to hold raceways or cables in place may be via tie wraps.

D. General Raceway Installation

1. Install the various types of raceways in permitted locations as previously specified. All raceways shall be run concealed. Consult Architect for instruction for raceways which must be exposed in public spaces.

a. Raceways for normal emergency or emergency only wiring cannot contain other conductors.
b. Raceways shall be properly aligned, grouped, and supported in accordance with code. Exposed raceways shall be installed at right angles to or parallel with structural members. Concealed raceways may take most direct route between outlets.
c. Raceways run on trapeze hangers shall be secured to the trapeze.
d. Raceways shall be continuous and shall enter and be secured to all boxes in such a manner that each system shall be electrically continuous from service to all outlets. Provide grounding bushings and bonding jumpers where raceways attach to painted enclosures or terminate below equipment.
e. Where raceways enter boxes, cabinets, tap boxes, other than those having threaded hubs, a standard locknut shall be used on the outside and locknut and bushing on the inside.
f. Where raceways terminate below equipment and there is no direct metal-to-metal continuity, provide grounding bushings on raceways and interconnect with equipment grounding conductor.
g. All empty raceways shall be provided with a pull wire.
h. All raceway sleeves, stub ups, or stub outs, where not connected to a box or cabinet, shall be terminated with a bushing.
i. All raceway joints shall be made up tight and no running threads will be permitted.
j. Where raceways are cut, the inside edge shall be reamed smooth to prevent injury to conductors.
k. Raceways shall not be installed in concrete slabs above grade or below waterproofed slabs.
l. Electric raceways and/or sleeves passing through floors or walls shall be of such size and in such location as not to impair strength of construction. Where raceways alter structural strength or the installation is questionable, the structural engineer shall be contacted for approval.
m. Raceways shall not run directly above or below heat producing apparatus such as boilers, nor shall raceways run parallel within 6 inches of heated pipes. Raceways crossing heated pipes shall maintain at least a 1 inch space from them.
n. Raceways shall be installed in such a manner as to prevent collection of trapped condensates, and all runs shall be arranged to drain.
o. Where two alternate wiring methods interconnect such as EMT to flexible metal conduit, an outlet box shall be provided.
p. All empty raceways entering building and all sleeves or core drilled openings through floors shall be sealed.
q. Each exterior raceway or assembly in a ductbank shall be provided with continuous warning tape installed 12 inches above raceway or ductbank.
r. Underground rigid non-metallic raceways where allowed and run as a ductbank encased in concrete shall be installed with plastic spacers to

ensure a separation of 3 inches between raceways. Top of ductbanks shall be 30 inches below grade, unless otherwise detailed.

s. Elbows and extensions of rigid non-metallic raceway systems which penetrate slabs shall be rigid or intermediate metal conduit.

t. Raceways used for transformer connections shall be flexible type and shall contain a grounding conductor.

u. Raceways entering building through foundation wall into a basement area shall be provided with wall entrance seals or with other acceptable waterproofing method.

E. General Outlet Box Installation:

1. Boxes shall be set flush with finish surface and provided with proper type extension rings or plaster covers. Through-the-wall boxes are not permitted. Check device or fixture to be mounted to box to ensure box orientation is proper.

a. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling-in operation.

b. Remove knockouts only as required and plug unused openings.

c. Where required for horizontal and vertical alignment of boxes in stud partitions, bar hangers spanning two studs shall be used. Device boxes for insertion type receptacles shall be provided with far side box supports where there are less than two entering nonflexible raceways, and where bar rangers are not provided.

d. Boxes flush mounted in fire rated partitions and on opposite sides of the partition shall be separated by a distance of 24 inches in accordance with UL listing for the box.

e. Locations of outlets indicated on drawings are approximate. For items exposed to view, refer to architectural drawings and coordinate locations with masonry joints, panel joints, ceiling grids, structural members, etc.

f. In case of conflict with standard mounting heights and device alignment, consult Architect prior to roughing.

g. Check all door swings on architectural drawings to ensure lighting switches are installed on strike side of door.

h. The right to make any reasonable change in location of outlets prior to roughing is reserved by Architect. "Reasonable change" shall be interpreted as movement within 10 feet of location shown.

i. Obtain dimensioned plan from Architect for floor outlets.

j. Outlet boxes for use where surface metal raceways are allowed shall be of a type specifically designed to be used with such surface metal raceway systems.

F. Conductor Installation

1. No conductors shall be pulled into individual raceways until such raceway system is complete and free of debris. No harmful lubricants shall be used to ease pulling.

a. All conductors shall be wired so that grounded conductor is unbroken; switches in all cases being connected in ungrounded conductor.

b. Connections throughout the entire job shall be made with solderless type devices of approved design satisfactory to Inspector of Wires.

c. All taps and splices shall be insulated equal to that of conductor insulation.

d. All conductors of each feeder in pull boxes etc. shall be grouped, tied together, supported, and identified.

e. All conductors in panelboards and other wiring enclosures shall be neatly formed and grouped.
f. All conductors of emergency only and/or normal/emergency shall be run in separate raceway systems to final outlet box.
g. Provide support for conductors in vertical raceways in accordance with Article 300 19.
h. Strip insulation from conductors with approved tools and only of sufficient length for proper termination. Cutting of conductor stranding is unacceptable.
i. Taps from paralleled conductors shall be of a type which tap each conductor, such as ILSCO "PTA" series.
j. Grounding conductors are to be identified as to associated power circuits.

G. Stranded Conductor Installation

1. If Contractor selects stranded conductors for # 10 AWG and smaller, terminate such conductors as follows:

a. No stranded conductor may be terminated under a screw head. Provide insulated terminal lugs for all screw connections equal to Thomas & Betts "STA KON" type RC with forked tongue and turned up toes. Installation of lugs shall be done with compression tool such as T&B WT 145C which prevents opening of tool until full compression action is completed.
b. Backwired wiring devices shall be of clamp type; screw tightened. Force fit connections not allowed.
c. Stranded conductors will not be allowed for fire alarm work.

H. Accessibility

1. Electrical equipment requiring service or manual operation shall be accessible.

a. Work switches for equipment within accessible hung ceiling spaces, such as fan powered terminal boxes, shall be located at terminal box, and so located so as to be accessible.

I. Vibration Elimination

1. All equipment connections to rotating equipment or equipment capable of vibration shall be made up by flexible raceways.

J. Wiring Device Gaskets

1. Provide wiring device gaskets at coverplates where device is mounted in wall separating conditioned and non-conditioned spaces.

3.9 FEEDER CIRCUITS

A. Provide feeders as called for on the drawings.

3.10 BRANCH CIRCUITS

A. Provide all branch circuit wiring and outlets for a complete and operating system. The system shall consist of insulated conductors connected to the panelboards and run in raceways or as cable systems if permitted under products section, as required to the final outlet and shall include outlet boxes, supports, fittings, receptacles, plates, fuses, etc.

B. Physical arrangement of branch circuit wiring shall correspond to circuit numbering on drawings. Ground fault circuit breakers and isolated ground outlets shall be wired with separate neutrals and separate grounding conductors per circuit. A consistent phase orientation shall be adhered to throughout project at terminations.

C. Circuits feeding three-phase equipment shall not be combined into common raceways, unless specifically indicated.

D. All wiring in panelboards and cabinets shall be neatly formed and grouped.

3.11 FIREPROOFING AND WATERPROOFING

A. Examination

1. Before beginning installation, verify that substrate conditions previously installed under other sections are acceptable for installation of firestopping in accordance with manufacturer's installation instructions and technical information.

B. Surfaces shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellants, and any other substances that may inhibit optimum adhesion.

C. Provide masking and temporary covering to protect adjacent surfaces.

D. Do not proceed until unsatisfactory conditions have been corrected.

E. Installation

1. General: Install through-penetration firestop systems in accordance with Performance Criteria and in accordance with the conditions of testing and classification as specified in the published design.
2. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of firestopping products.

F. Field Quality Control

1. Inspections: Owner shall engage qualified independent inspection agency to inspect through-penetration firestop systems.
2. Keep areas of work accessible until inspection by authorities having jurisdiction.
3. Where deficiencies are found, repair firestopping products so they comply with requirements.

G. Adjusting and Cleaning

1. Remove equipment, materials, and debris, leaving area in undamaged, clean condition.
2. Clean all surfaces adjacent to sealed openings to be free of excess firestopping materials and soiling as work progresses.

H. Schedules

	Concrete Floor	Concrete Wall
Penetrant Type		
Blank Opening	C-AJ-0100, C-AJ-0101	C-AJ-0100, C-AJ-101
Metal Conduits	C-AJ-1080, C-AJ-1240, C-AJ-1353	C-AJ-1080, W-J-1098, W-J-1100
Plastic Conduits/ Raceways	C-AJ-2140, C-AJ-2292	W-J-2018, W-J-2076
Cables	F-A-3021, F-A-3037	W-J-3098, W-J-3130, W-J-3158, W-J-3180
Pipes/conduits thru foundation walls		Emerson - WSK

3.12 DISTRIBUTION EQUIPMENT TESTING

A. All dry-type transformers, individual motor starters, switchboard and main distribution panels, motor controls, motor control centers, feeder conductors, branch circuits and emergency systems shall be tested in accordance with the following. In general, all tests shall be done in accordance with the 2009 Acceptance Testing Specifications of the International Electrical Testing Association.

B. The Testing Subcontractor may be an independent contractor or a manufacturer of the equipment which is to be tested.

C. Test report forms, delineating tests to be made, and method of recording same shall be submitted prior to commencing work. Test reports when submitted shall include interpretation of results and recommendation for any corrective work required.

D. Panel boards

1. Visual Inspection:

a. Check for foreign material within bus enclosure.
b. Check for missing hardware.
c. Inspect entire assemblies for transit damage or factory defects.
d. Check for all bus dimensions and bracing per specifications.
e. Check ratings of current transformers and potential transformers.
f. Check ratings of all protective relays per drawings.
g. Physical Inspection:
h. Torque all bus hardware to proper tension.
i. Circuit breaker interlocks all work properly.
j. All doors and hinged panels open and close properly.
k. All circuit breakers operate, close and trip mechanically.
l. Torque all feeder conductors to terminal manufacturers' recommendations.
m. Electrical Testing:
n. Insulation resistance tests made on all circuit breakers, line to load breaker open, line to ground breaker closed, 3 poses tested individually. Switchgear bus to be tested phase to phase and phase to ground with Megohometer type instrument. Relays also to be insulation resistance tested.

E. Conductors: All secondary service conductors, all feeder, as well as, all branch circuits conductors from switchboards, distribution panels, panel boards, and load centers shall be tested.

1. Visual and mechanical inspection

a. Conductors to be inspected for physical damage and proper connection and sizing in accordance with single line diagram.
b. Conductor connections shall be torque tested to manufacturer's recommended values.
c. Electrical Tests
1. Perform insulation resistance test on each conductor with respect to ground and adjacent conductor.
2. Perform continuity test to insure proper conductor connection.

F. Grounding Grids or Electrodes: Measurement of resistance from ground grids or electrodes to earth to determine adequacy of grounding system in building and compliance with specifications and/or electrical code.

G. Settings of Adjustable Devices: Using the result of the fault current and coordination study specified hereinafter, the Testing Contractor shall set all adjustable devices.

3.13 ARC FLASH ANALYSIS

A. Employ the manufacturer of the secondary distribution equipment or an independent organization to perform a fault current and coordination study to ensure a selectively coordinated system from the incoming mains to the branch circuit panelboards.

B. The report shall be submitted in a standard format and shall include the fault current availability at various points in the distribution system, breaker coordination curves, and recommended settings of all adjustable devices in the system.

C. Scope

1. The contractor shall furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer or an approved engineering firm.

a. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in NFPA 70E-Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2021, Annex D.
b. The scope of the studies shall include all new distribution equipment supplied by the equipment Manufacturer under this contract as well as all directly affected existing distribution equipment at the customer facility.

D. References

1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

a. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems.

b. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
c. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis.
d. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings.
e. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
f. IEEE 1584 - Guide for Performing Arc-Flash Hazard Calculations.
g. American National Standards Institute (ANSI):
h. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
i. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures.
j. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
k. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.
l. The National Fire Protection Association (NFPA):
m. NFPA 70 - National Electrical Code, latest edition.
n. NFPA 70E – Standard for Electrical Safety in the Workplace.

E. Submittals for Review Approval

1. The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

F. Submittals for Construction

1. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. No more than five (5) bound copies of the complete final report shall be submitted. For large system studies, submittals requiring more than five (5) copies of the report will be provided without the section containing the computer printout of the short-circuit input and output data. Additional copies of the short-circuit input and output data, where required, shall be provided on CD in PDF format. The report shall include the following sections:

a. Executive Summary.
b. Descriptions, purpose, basis and scope of the study.
c. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.
d. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.
e. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
f. Details of the incident energy and flash protection boundary calculations.
g. Recommendations for system improvements, where needed.
h. One-line diagram.
i. Arc flash labels shall be provided in hard copy only.

G. Qualifications

1. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies

   a. The Registered Professional Electrical Engineer shall be a full-time employee of the equipment manufacturer or an approved engineering firm
   b. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies
   c. The equipment manufacturer or approved engineering firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year

H. Computer Analysis Software

1. The studies shall be performed using the latest revision of the SKM Systems Analysis Power*Tools for Windows (PTW) software program

I. Studies

1. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer or an approved engineering firm.

   a. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

J. Data Collection

1. Contractor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

   a. Source combination may include present and future motors and generators.
   b. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner, or Contractor.
   c. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

K. Short-Circuit and Protective Device Evaluation Study

1. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141-1993.

a. Transformer design impedances shall be used when test impedances are not available.
b. Provide the following:
c. Calculation methods and assumptions.
d. Selected base per unit quantities.
e. One-line diagram of the system being evaluated.
f. Source impedance data, including electric utility system and motor fault contribution characteristics.
g. Tabulations of calculated quantities.
h. Results, conclusions, and recommendations.
i. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
j. Electric utility's supply termination point
k. Incoming switchgear
l. Unit substation primary and secondary terminals
m. Low voltage switchgear
n. Motor control centers
o. Standby generators and automatic transfer switches
p. Branch circuit panelboards
q. Other significant locations throughout the system.
r. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.
s. Protective Device Evaluation:
t. Evaluate equipment and protective devices and compare to short circuit ratings
u. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
v. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

L. Protective Device Coordination Study

1. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

a. Include on each TCC graph, a complete title and one-line diagram with legend identifying the specific portion of the system covered.
b. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
c. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
d. Plot the following characteristics on the TCC graphs, where applicable:
e. Electric utility's overcurrent protective device
f. Medium voltage equipment overcurrent relays
g. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
h. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
i. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
j. Conductor damage curves
k. Ground fault protective devices, as applicable
l. Pertinent motor starting characteristics and motor damage points, where applicable

m. Pertinent generator short-circuit decrement curve and generator damage point
n. The largest feeder circuit breaker in each motor control center and applicable panelboard.
o. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

M. Arc Flash Hazard Analysis

1. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2021, Annex D.

a. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
b. The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.
c. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.
d. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations
e. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.
f. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
g. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
h. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).
i. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

j. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.
k. Miscoordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
l. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

N. Report Sections

1. Input data shall include, but not be limited to the following:

a. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
b. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
c. Reactor data, including voltage rating, and impedance.
d. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance (X"d), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
e. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.
f. Short-Circuit Output Data shall include, but not be limited to the following reports:
g. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

1) Voltage
2) Calculated fault current magnitude and angle
3) Fault point X/R ratio
4) Equivalent impedance

h. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

1) Voltage
2) Calculated symmetrical fault current magnitude and angle
3) Fault point X/R ratio
4) Calculated asymmetrical fault currents

a) Based on fault point X/R ratio
b) Based on calculated symmetrical value multiplied by 1.6
c) Based on calculated symmetrical value multiplied by 2.7

5) Equivalent impedance

i. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

1) Voltage.
2) Calculated symmetrical fault current magnitude and angle.
3) Fault point X/R ratio.
4) No AC Decrement (NACD) Ratio.
5) Equivalent impedance.
6) Multiplying factors for 2, 3, 5, and 8 cycle circuit breakers rated on a symmetrical basis.
7) Multiplying factors for 2, 3, 5, and 8 cycle circuit breakers rated on a total basis.

j. Incident energy and flash protection boundary calculations:
k. Arcing fault magnitude.
l. Protective device clearing time.
m. Duration of arc.
n. Arc flash boundary.
o. Working distance.
p. Incident energy.
q. Hazard Risk Category.
r. Recommendations for arc flash energy reduction.

O. Field Adjustment

1. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

a. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
b. Notify Owner in writing of any required major equipment modifications.
c. Arc Flash Warning Labels

2. The contractor of the Arc Flash Hazard Analysis shall provide a 3.5” by 5” thermal transfer type label of high adhesion polyester for each work location analyzed.

a. All labels will be based on recommended over-current device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.
b. The label shall include the following information, at a minimum:
1. Location designation.
2. Nominal voltage.
3. Flash protection boundary.
4. Hazard risk category.
5. Incident energy.
6. Working distance.
7. Recommend PPE.

c. Engineering report number, revision number, and issue date.
d. Labels shall be machine printed, with no field markings.
e. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
f. For each 600, 480 and applicable 208 volt panelboard, one arc flash label shall be provided.
g. For each motor control center, one arc flash label shall be provided.
h. For each low voltage switchboard, one arc flash label shall be provided.
i. For each switchgear, one flash label shall be provided.
j. Labels shall be field installed by the electrical contractor.

END OF SECTION

SECTION 31 00 00 - EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Attention is directed to the printed form of the Contract of the City of Worcester and Division 1 of which these specifications are hereby made a part.

1.2 DESCRIPTION OF WORK

A. Excavating, filling, backfilling and grading as required for the construction of paving and other site work.
B. Providing, furnishing and placing of all fill and backfill materials as specified herein, as shown on the Drawings or as required.
C. Compaction and decompaction procedures.
D. Protecting all existing structures, utilities, pavements, planting and other site improvements from damage due to construction.
E. Performing all dewatering necessary to maintain excavated areas free from water from any source.
F. Removal of underground utilities as applicable.
G. Bedding for utility trenches.
H. Removing and disposing of all unsuitable and surplus excavated materials from the site.
I. Coordinate with all trades for site utility systems.
J. Coordination with City staff of safe path of travel for the public.

1.3 RELATED WORK

A. The following items of related work are specified and included in other Sections of the Specifications:

1. Section 02 41 13 - Site Preparation
2. Section 03 30 00 - Cast in Place Concrete
3. Section 26 00 00 - Electrical
3. Section 32 12 16 - Bituminous Concrete Pavement
4. Section 32 14 00 - Unit Paving
5. Section 32 30 00 - Site Improvements
6. Section 32 84 00 - Irrigation System
7. Section 32 90 00 - Lawns and Planting

1.4 REFERENCES

A. AASHTO: American Association of State Highway and Transportation Officials.
B. ANSI A10 Series standards: American National Standards Institute, "Safety Requirements for Construction and Demolition".
C. ASTM: American Society of Testing Materials.
D. MassDOT: "Standard Specifications for Highways and Bridges", Massachusetts Department of Transportation, Commonwealth of Massachusetts, latest edition.

1.5 QUALITY ASSURANCE

A. Comply with all codes, laws, ordinances and regulations of governmental authorities having jurisdiction over this part of the work.

B. Provide protection for all persons and property in accordance with ANSI/NFPA 241, Building Construction and Demolition Operations. Execute all work in such a manner as to protect existing buildings, paving, utility lines, structures, fences and adjoining property from damage by equipment, settlement, undermining, washout, frost and other hazards created by earthwork operations.

1.6 TESTING SERVICES

A. The testing laboratory will be responsible for conducting and interpreting tests, state in each report whether or not the test specimens conform to all requirements of the Contract Documents and specifically note any deviation there from. Specific test and inspection requirements shall be as specified herein.

1.7 SUBMITTALS

A. Test Reports:

1. Gradation tests for all soil materials.
2. Optimum moisture - maximum density of soils.
3. Field density tests.

B. Product Data: For the following:

1. Each type of plastic warning tape.
2. Geotextile.
3. Controlled Density Fill, including design mixture.

E. Dewatering system: Contractor shall submit, for record, drawings and design data prepared, stamped, and signed by a registered professional engineer in the Commonwealth of Massachusetts who is experienced in groundwater control system design. The submittal shall show arrangement locations, and details of wells and well points and sump pumps; locations of risers, headers, filters, pumps, power units, all treatment components, and discharge lines; and means of discharge, control of sediment, and disposal of water. The submittal of the dewatering system will not relieve the Contractor from the responsibility for the adequacy of the dewatering system to achieve the required results specified in these Specifications and all permit requirements.

1. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
2. Include a written plan for dewatering operations including control procedures to be adapted if dewatering problems arise.
3. Include design calculations demonstrating adequacy of the proposed dewatering sys- tem and equipment.
4. Provisions and methods of sediment removal and disposal of water.
5. All permits required for the work.

F. Support of Excavation: Contractor shall submit, for record, proposed excavation support sys- tems (if required). The proposed lateral support systems shall be designed and stamped by a registered professional engineer licensed in the Commonwealth of Massachusetts. De- spite the submittal of the design of excavation support and protection systems, the Contractor shall remain solely responsible for the adequacy and safety of materials and methods used in construction. Include the following as a minimum on the drawings:

1. Details, arrangements, and methods of construction of the proposed system(s).

2. The method of installation and installation equipment.
3. The elevation of struts, shores, and tiebacks, as applicable, and permissible depth to which excavation may be carried before such supports are installed.
4. The excavation depths, the depth below the main excavation to which the support system will be installed, and the maximum design load to be carried by various members of the support system.
5. Design calculations including references to design methods used, assumptions, design parameters, design soil profile, material properties, allowable stresses, and other pertinent information stamped by a Professional Engineer registered in the Commonwealth of Massachusetts.
6. The location of existing utilities, facilities and/or structures nearby.

F. Pre-Excavation Photographs and Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins. Maintain catalog of up- to date photographs at the site.

G. Plan to Maintain Safe Path of Travel: Submit plans for maintaining safe paths of travel for the general public during the entire project, including requirement for police details of necessary.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect and handle manufactured materials during loading, shipping, unloading at the site, storage and erection as required to prevent damage.

1.7 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others unless permitted in writing by the Owner's Representative and then only after arranging to provide temporary utility services according to requirements indicated.
1. Notify the Owner's Representative not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without the Owner's Representative's written permission.
3. Contact utility-locator service for area where Project is located before excavating.
a. The Contractor shall notify "Dig Safe" at 1-888-DIG-SAFE prior to commencing any excavation work.

B. Demolish and completely remove from site existing underground utilities and structures indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

C. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Neither the Owner nor the Geotechnical Engineer will be responsible for interpretations or conclusions drawn from the data.
1. The geotechnical report does not represent, and shall not be construed to represent a guarantee of subsurface conditions.
2. Interpretation of this data for purposes of construction is the responsibility of the Con- tractor. It is the Contractor's responsibility to make interpretations and draw conclusions with respect to the character of materials to be encountered and groundwater conditions at the site and their impact upon Contractor's work based on his expert knowledge of the area, construction dewatering methods, and support of excavation methods.

3. Make additional test borings and conduct other exploratory operations necessary for dewatering and excavation support and protection.
4. The geotechnical report is referenced elsewhere in the Project Manual.

D. Survey Work: Contractor shall engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact eleva- tions at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During earth moving operations, installation of excavation support and protection sys- tems and dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Owner's Representative if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

E. The Contractor shall not close or obstruct any street, sidewalk, or passageway without written permission from authorities having jurisdiction unless otherwise indicated on the Contract Drawings. The Contractor shall conduct the construction operations as to minimize interfer- ence with the use of roads, driveways, or other facilities near enough to the project to be affected by the work.

F. The Contractor shall provide police details when working in roadways as required by local jurisdictional authorities. The Contractor shall pay for any and all police details.

1.7 EXCAVATION SUPPORT AND PROTECTION

A. The Contractor shall furnish, install, monitor and maintain excavation support and protection systems (sheeting, shoring, and bracing) at locations necessary to support the sides of ex- cavations and resist soil and hydrostatic pressure and superimposed and construction loads; to prevent danger to persons or damage to adjacent pavements, facilities, utilities, or struc- tures; to prevent injurious caving or erosion or the loss of ground; and to maintain pedestrian and vehicular traffic as required by the Contract Documents, the Contractor's sequence of construction, and as directed by the Owner's Representative.

B. In all sheeting, shoring and bracing operations, care shall be taken to prevent collapse of excavations, injury to persons or damage to adjacent structures, facilities, utilities, and ser- vices. Any injuries to persons shall be the responsibility of the Contractor; and any damage to the work occurring as a result of settlement, water or earth pressure, or other causes due to inadequate bracing or other construction operations of the Contractor shall be satisfactorily repaired and made good by the Contractor, at no additional cost to the Owner.

C. The excavation support system shall be of sufficient strength and be provided with adequate bracing to support all loads to which it will be subjected. The excavation support system shall be designed to prevent any movement of earth that would diminish the width of the excava- tion or damage or endanger adjacent structures.

D. Where sheeting is to be used, it shall be driven ahead of excavation operations to the extent practicable so as to avoid the loss of material from behind the sheeting; where voids occur outside of the sheeting, they shall be filled immediately with ordinary fill, thoroughly com- pacted.

E. The Contractor shall leave in place all sheeting and bracing at the locations and within the limits ordered by the Owner's Representative in writing. The Contractor shall cut off the sheet- ing at elevations as indicated on the Contract Drawings or to be determined with the approval of the Owner's Representative.

F. The Contractor shall comply with all federal, state, and local safety regulations, and require- ments.

1.8 DEWATERING

A. The Contractor shall provide, at his own expense, adequate pumping and drainage facilities to maintain the excavated area sufficiently dry from groundwater and/or surface runoff so as not to adversely affect construction procedures nor cause excessive disturbance of underlying natural ground. The flows of all water resulting from pumping shall be managed so as not to cause erosion, siltation of drainage systems, or damage to adjacent property.

B. Any damage resulting from the failure of the dewatering operations of the Contractor, and any damage resulting from the failure of the Contractor to maintain all the areas of work in a suitable dry condition, shall be repaired by the Contractor, as directed by the Owner's Representative and/or the Designer, at no additional cost to the Owner. The Contractor's pump- ing and dewatering operations shall be carried out in such a manner as to prevent damage to the Contract work and so that no loss of ground will result from these operations. Precau- tions shall be taken to protect new work from flooding during storms or from other causes. Pumping shall be continuous to protect the work and/or to maintain satisfactory progress.

C. All pipelines or structures not stable against uplift during construction or prior to completion shall be thoroughly braced or otherwise protected. Water from the trenches, excavations, and stormwater management operations shall be disposed of in such a manner as to avoid public nuisance, injury to public health or the environment, damage to public or private property, or damage to the work completed or in progress.

D. The Contractor shall control the grading in the areas surrounding all excavations so that the surface of the ground will be properly sloped to prevent water from running into the excavated area. Where required, temporary ditches shall be provided to control drainage. Upon completion of the work and when directed, all areas shall be restored by the Contractor in a satisfactory manner and as directed.

E. Remove dewatering system when no longer required for construction.

F. The Contractor shall obtain and maintain all required local, state, and federal permits necessary for construction dewatering for the duration of dewatering activities including all chemical testing required for disposal and discharge of dewatering effluent. The Contractor shall be responsible for treatment of water, if necessary, to meet minimum discharge criteria specified in the permits.

1.9 QUALITY CONTROL

A. Inspection and testing will be performed by the Contractor to ensure that the materials placed meet the requirements in this section. Fill materials imported from off-site sources shall be chemically and geotechnically tested once for every 2,000 tons of material.

B. If fill soils are not obtained from a commercial gravel pit, the Contractor shall provide certified analytical testing of offsite backfill to demonstrate that the soil does not exceed the limitations for MCP reference/reportable concentrations. Analyses shall include RCRA-8 metals, Extractable and Volatile Petroleum Hydrocarbons (EPH/VPH), and Volatile Organic Com- pounds (by EPA Method 8260B/5035). No testing will be required of imported fill soils ob- tained from a commercial gravel pit, provided the soils are free of odors, discoloration, stain- ing or other conditions indicative of contamination, in the opinion of the Geotechnical Engi- neer and/or the Designer.

C. Tests and analysis of soil material will be performed in accordance with ASTM D422, ASTM D1557, ASTM D2922, ASTM D3017 and ASTM D4318.

D. If tests indicate materials do not meet specified requirements, the Contractor shall identify an alternative borrow source, test the new material, and submit results to the Designer at no cost to Owner.

1.10 LAYOUT AND GRADES

A. The Contractor is responsible for establishing vertical and horizontal control for the work and shall establish permanent bench marks and replace as directed any that are destroyed or disturbed. The Contractor shall maintain sufficient reference points at all times during construction to properly perform site grading. The existing survey benchmark shall be protected throughout the construction project.

B. Finished grades, contours, and elevations indicated on the Drawings describe final surface elevation for completed construction. The words “finished grade” as used herein shall mean final grade elevations indicated on the Drawings. Spot elevations shall govern over proposed contours. Where not otherwise indicated, project site areas shall be given uniform slope between points and existing established grades.

1.9 BENCH MARKS AND ENGINEERING

A. Line and grade work in accordance with the Drawings and Specifications shall be laid out by a registered Civil Engineer or Land Surveyor employed by the Contractor. Establish permanent bench marks, as required, to which access can be easily had during the progress of the work. Maintain all established bounds and bench marks and replace as directed any which are disturbed or destroyed. Establish lines and grades in conformity with the Drawings. Provide sufficient grade stakes to witness correct lines and grades.

B. Verify dimensions and elevations on the ground and report any discrepancies immediately to the Owner’s Representative. Any discrepancies not reported prior to construction shall not be the basis for claims for extra compensation.

C. The Drawings indicate, in general, alignment and finish grade elevations. The Owner’s Representative, however, may make such adjustments in grades and alignments as are found necessary in order to avoid interference with any special conditions encountered.

1.10 DEFINITIONS

A. Fill and backfill shall be, for the purpose of this Specification, considered interchangeable terms and shall mean material to be used to bring existing or construction grades up to finish subgrade levels.

B. The words "finish grade" as used herein mean the required final grade elevations indicated on the Drawings.

C. The word "subgrade" as used herein, means the required surface of subsoil, borrow fill or compacted fill. This surface is immediately beneath the site improvements, specially dimensioned fill, paving, loam or other surfacing materials.

D. Excavation is defined as the removal of materials from the construction area to the lines and grades shown on the plans.

1. Unclassified Excavation is defined as the removal of all material encountered regardless of its nature. All material excavated will be considered as Unclassified Excavation unless the Special Provisions specify Classified Materials.

E. "Unsuitable Materials" shall include the following:

1. Pavements, utility structures, building foundations and other manmade structures.
2. Peat, muck, organic silt and other organic materials subject to decomposition, consolidation or decay.
3. Miscellaneous fill including cinders, ash, glass, wood, masonry and metal.
4. Ledge and boulders except as specified herein for fills.

1.11 EXISTING CONDITIONS

A. Subsurface Information: The Owner’s Representative assumes no responsibility for the Contractor's failure to make his own site investigation and makes no representation regarding the character of the soil or subsurface conditions which may be encountered during the performance of the work. Bidders are expected to examine the site and then decide for themselves the character of materials to be encountered.

B. Existing Utilities

1. Before starting earthwork, locate existing underground utilities in areas of work. If utilities are to remain in place, 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 Owner.
3. Do not interrupt existing utilities serving facilities occupied or used by Owner and others, during occupied hours, except when permitted in writing by Owner and then only after acceptable temporary utility services have been provided. Provide minimum of 48 hour notice to Owner, and receive written notice to proceed before interrupting any utility.

C. Retaining Structures: Provide bracing, shoring, sheeting, temporary tie backs, rock anchors and rock bolts, sheet piling, underpinning or other retaining structures necessary to prevent any movement or settlement of existing or new construction, utilities, paving, piping or conduit.

PART 2 – PRODUCTS

2.1 SOIL MATERIALS

A. ORDINARY FILL shall conform to the requirements of Section M1.01.0 of MassDOT. In addition, it shall be clean, mostly granular, natural inorganic soil. It shall be free of organic or other weak or compressive materials, frozen materials, cinders, trash, rubble and stone larger than six (6) inches maximum dimension.

1. Material from excavation on the site meeting the above requirements may be used as ordinary fill provided it has not been contaminated with unsuitable material.

B. GRANULAR FILL for borrow shall conform to the requirements of Section M1.03.0, Type c of MassDOT with 2 inches being the largest dimension.

C. GRAVEL, as noted in the Drawings, shall be DENSE GRADED CRUSHED STONE conforming to the requirements of Section M2.01.7 of MassDOT.

D. CRUSHED STONE CHOKER COURSE shall conform to the requirements of Section M2.01.4 of MassDOT for 3/4” maximum sieve size.

E. CRUSHED STONE equal to ASTM No. 57 Open Graded Material. All aggregate material shall be crushed, angular stone and free of fines.

F. CRUSHED STONE, 3/8” pea gravel equal to ASTM No. 2. All aggregate material shall be crushed, angular stone and free of fines.

G. CRUSHED STONE, 3/4” open graded gravel equal to ASTM No. 2. All aggregate material shall be crushed, angular stone and free of fines.

H. GRAVEL BORROW FOR BACKFILLING STRUCTURES AND PIPES, as noted on the Drawings, shall conform to the requirements of Section M1.03.0, type b of MassDOT.

I. SAND shall conform to the requirements of Section M1.04.1 of MassDOT.

2.2 USE OF FILL MATERIALS

A. Granular Fill shall be utilized as fill in the following locations:

1. To replace unsuitable material.
2. All walk embankments to subgrade.
3. Elsewhere as shown on the Drawings or specified. Wherever fill materials such as Ordinary Fill or Gravel have not been specified herein or shown on the Drawings.

B. Gravel shall be utilized as sub-base material for all paved surfaces, where so indicated on the Drawings or specified herein.

C. Crushed Stone shall be utilized as base materials for porous bituminous concrete paving, where so indicated on the Drawings.

D. Sand shall be utilized for the bedding of utilities and where so indicated on the Drawings or specified herein.

2.3 ACCESSORIES

A. Detectable Underground Warning Tapes: Acid and alkali-resistant polyethylene plastic film warning tape, 6-inches wide by 4-mils minimum thickness, with continuously printed caption in black letters "CAUTION - xxxxx LINE BURIED BELOW." The text and color of the tape shall be as shown in the table below. The tape shall have a metallic core encased in a protective jacket for corrosion protection and be detectable by a metal detector when the tape is buried up to 2.5-feet deep.

Color	Utility
Safety Red	Electric
High Visibility Safety Yellow	Gas, Oil, Steam
Safety Alert Orange	Telephone, Communications, Cable Television
Safety Precaution Blue	Water System, Irrigation
Safety Green	Sanitary Sewer, Storm Sewer
White	Proposed Excavation

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. The Contract Drawings indicate the proposed finish alignment, elevation, and grade of the work. Establish the line and grade in close conformity with the Contract Drawings.

B. The Contractor is responsible for establishing construction phasing, means, and methods and interim grading and temporary conditions required to attain the finish product required by the Contract Documents. The Contractor is responsible for all construction, protection, movement, and maintenance of stockpiles. Establish and maintain suitable benchmarks and grade control to accurately perform the work.

C. No excavation shall be deposited or stockpiled at any time to endanger portions of new or existing structures, either by direct pressure or indirectly by overloading banks contiguous to the operation. Material, if stockpiled, shall be stored so as not to interfere with the established sequence of the construction. If there is not sufficient area available for stockpiling within the limits of the project, the Contractor will be required to furnish his own area for stockpiling.

D. When the plans require excavation in areas in close proximity to existing buildings, roads, structures and utilities it shall be the responsibility of the Contractor at his expense to use satisfactory means and methods to protect and maintain the stability of such roads, and structures located immediately adjacent to but outside the limits of excavations.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth- work operations.

B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Section 311000 - SITE CLEARING.

C. Protect and maintain erosion and sedimentation controls, which are specified in Section 312500 – EROSION AND SEDIMENTATION CONTROLS, during earthwork operations.

D. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

3.3 EXCAVATION

A. Excavation is "Unclassified", and includes excavation to subgrade elevations indicated, or required to accommodate new construction, lawns, plant beds and pathways, regardless of character of materials and obstructions encountered and shall be understood to include rock, shale, boulders, earth, hardpan, fill, foundations, pavements, curbs, piping and debris. It shall include the removal of all rubble, debris, foundations, pavement, utilities, gravel and appurtenances up to one (1) foot minimum below finish grade.

B. Before any other work is begun in this Section, topsoil shall be stripped in accordance with the standards specified in Section 02 41 13, SITE PREPARATION.

1. Pile topsoil separately from all other material in locations on the site approved by the Owner and authorities having jurisdiction and preserve for finish grading and lawn operations specified under Section 32 90 00, LAWNS AND PLANTING. Place, grade and shape stockpile for proper drainage.
2. Contractor shall screen existing topsoil for use on site in new lawn areas, plant beds and for backfill at new tree plantings. Screening will remove debris, tree roots, stones, metals and plastics.
3. Screened topsoil that remains on site shall be tested according to Section 32 90 00, LAWNS AND PLANTING, in this specification. Topsoil shall be amended per results of soil tests.
4. All topsoil shall remain on the property of the Owner and shall not be removed from the site. However, if excess topsoil is not required for operations specified under Section 32 90 00, LAWNS AND PLANTING, topsoil shall be removed from the site only after receiving written permission from Owner.l

C. Additional Excavation: When excavation has reached required subgrade elevations, notify Owner's Representative who will make an inspection of conditions.

1. If suitable bearing material, as determined by Owner's Representative, is not encountered at the subgrade elevations indicated, carry excavations deeper and replace excavated material with granular fill. Additional excavation work must be authorized in writing before additional excavation work can be performed.
2. Removal of unsuitable material and its replacement as directed will be paid on basis of Contract conditions relative to changes in work.

D. Excavate to the following basic subgrades:

1. Footings and other site improvements: To exact elevations required.
2. Walk Surfacing: To elevations indicated on the Drawings.
3. New Lawns: To approximately 6" below finish grade.

E. Excavation for Utility Trenches

1. Excavate trenches to indicated gradients, lines, depths, and elevations.
   a. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
2. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
   a. Clearance: 12 inches each side of pipe or conduit.
3. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
   a. For pipes and conduit less than 6 inches in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
   b. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.
   c. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

E. Unauthorized Excavation: When suitable bearing material is encountered at subgrade elevations shown and excavation is made to greater depth, bring grade back to elevation required by providing granular fill at no additional cost to the City.

F. Rock Excavation

1. The material to be excavated shall be assumed for bidding purposes to be earth and other materials that can be removed by normal power excavation equipment. This includes rock, concrete and other subsurface materials up to and including two [2] cubic yards in volume encountered during excavation. Excavation of this material shall be at the Contractor's expense.
2. Rock or ledge shall be defined as follows:

    a. Open Ledge - Class A: Rock, stone or boulders over two [2] cubic yards in volume to be removed and disposed of from an open area normally by bulldozer, power shovel or similar type equipment.
    b. Trench Ledge - Class A: Rock, stone or boulders over one [1] cubic yard in volume to be removed and disposed of from a confined area normally by backhoe or similar type equipment.
    c. Open Ledge - Class B: Rock, stone or boulders over two [2] cubic yards in volume that can be removed only by blasting or pneumatic equipment.
    d. Trench Ledge - Class B: Rock, stone or boulders over one [1] cubic yard in volume that can be removed only by blasting or pneumatic equipment.
    e. Anything other is "earth" insofar as removal of the material to be excavated is concerned.

3. When, during the process of excavation, rock is encountered, uncover such materials and free them of loose material. Notify the Owner’s Representative before proceeding further. The area in question shall be cross sectioned as stipulated herein. Do not proceed with excavation of material claimed as rock until the material has been classified by the Owner’s Representative. Failure on the part of the Contractor to uncover such materials or notify the Owner’s Representative or take cross sections will forfeit the Contractor's right of claim to any credits. The quantity of rock to be removed shall be based upon the pay line limits as established herein. The quantity of rock to be removed shall be approved by the Owner’s Representative prior to blasting.

4. The Contractor shall employ and pay for a Land Surveyor or Civil Engineer registered in Massachusetts to take cross sections of rock before removal of same and to provide computations of cross sections within the pay line limits. Complete current records of actual quantities of rock excavated, methods of excavation used and extent of labor and equipment involved shall be maintained jointly by the Contractor and Owner’s Representative, and shall be dated and signed by both with duplicate copies retained by the Owner’s Representative for record. Such records shall include plot plans showing at a suitable scale all elevations, locations and measurements or computed volumes of rock or boulders encountered. All labor and equipment necessary to make these plot plans and take these measurements shall be furnished by the Contractor. No payment will be considered for rock which has been removed without obtaining the above required data.

5. Excavate rock encountered in grading the site areas to depths as follows:

    a. Under new footings: to six [6] inches below the required subgrade for such footing or piping.

6. Blasting: The use of explosives will not be permitted.

7. If rock is encountered the Contract Price will be adjusted in accordance with industry standard prices.

8. The additional price for rock removal shall include filling the void created by removal of the rock beyond the indicated limits of excavation with suitable materials in accordance with paragraphs on Fill, Backfill and Compaction at no added cost to the Owner. No allowance shall be made by the Contractor on account of rock or ledge, if encountered, reducing the amount of ordinary fill material available for filling operations, the Contractor being responsible to provide all such required material whether obtained from on or off the site.

9. The Owner's Representative reserves the right to adjust the proposed elevations to conform to any rock conditions.

G. Slope sides of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.

H. Dewatering: Prevent water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in the excavations. Remove water to prevent softening of foundation bottoms, undercutting footings and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
2. Establish and maintain temporary drainage ditches and their diversions outside excavation limits to convey rain water and water removed from excavations to collecting or runoff areas. Do not use trench excavations as temporary drainage ditches. The disposal of water from excavations shall not cause damage to adjacent property and shall be in compliance with all applicable laws and regulations, in particular, those related to protection of water resources and other environmental features.
3. Keep the water level in areas being compacted at least two (2) feet below the level at which compaction is being done at all times. Under no circumstances lay pipe or install appurtenances in water. Keep all trenches free from water until they have been backfilled.

I. Material Storage: Stockpile satisfactory excavated materials where directed until required for backfill or fill. Place, grade and shape stockpiles for proper drainage. Do not store within drip line of trees to remain.

J. 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 footings and foundations to permit placing and removal of formwork, installation of services, other construction and for inspection.

K. Frost Protection:

1. Make no excavations to full depth indicated when freezing temperature may be expected unless intended improvements can be accomplished immediately after the excavations have been completed. Protect bottom so excavated from frost if progress is delayed. Protect the subgrade of in place footings from frost. Should protection fail remove frozen materials and replace with concrete or granular fill as directed at no cost to Department.
2. Keep the site clear and free of accumulations of snow within the limit of the Contract lines as necessary to carry out the work of the Contract.

3. Fill materials containing frost shall not be utilized, nor shall filling be done over frozen material.
4. Protect the underside of all in place construction from frost penetration during the construction period of this Contract. Such protection shall include all in place footings and slabs, during all periods of freezing temperatures until such time as the entire project is complete. Minimum frost protection shall consist of a 4 foot thickness of earth, or equivalent in insulating properties.

3.2 BACKFILL AND FILL

A. Place acceptable soil material in layers to required subgrade elevations, for each area classification listed below.
1. Under paving and surfacing: Use subbase material, or satisfactory excavated or borrow material, or combination of both.

B. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Acceptance of construction below finish grade.
2. Backfilling of voids with satisfactory materials.

C. Placement and Compaction: Place backfill and fill materials in uniform lifts of not more than 6 inches in loose depth for material compacted by hand operated mechanical compactors.

1. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification.
2. Place backfill and fill materials adjacent to structures evenly to required elevations. Take care to prevent wedging action of backfill against structures by carrying material uniformly around structure to approximately the same elevation in each lift.
3. Do not place any fill material until structural components involved have sufficient strength to withstand the pressure to be imposed. Remove from spaces to be filled all unstable material, including all rubbish, trash, refuse and other debris.
4. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
5. Coordinate backfilling with the installation of the work of all trades.
6. Compact backfill to match adjacent areas as specified above. Correct settlement of fill by filling to subgrade levels in all areas where settlement occurs.

3.3 SUBGRADE PREPARATION AND GRAVEL PLACEMENT FOR PAVEMENTS

A. Clean the rough subgrade of all loose, soft, foreign or other unsuitable material and reshape as required. Add suitable fill material to meet required grade.

B. Compact to required grades and sections for paving. Remove spongy or otherwise unsuitable material and replace with approved material. Loosen exceptionally hard spots and recompact. Take every precaution to obtain a foundation of uniform bearing power. In absence of specific requirement, compact foundations by such means as will provide firm base and insurance against settlement of superimposed work.

1. Compact any portion which is not accessible to a roller by mechanical or hand tamper.

C. Maintain the surface of any layer in its finished condition until succeeding layer is placed. Properly drain the subbase at all times.

3.4 COMPACTION

A. Control soil compaction during construction providing minimum percentage density specified for each area classification.

B. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density of soils which exhibit a well defined moisture density relationship determined in accordance with ASTM D1557, Method C.

1. Pavements and Site Improvements: Compact top 12 inches of subgrade and each layer of backfill or fill material at 85 percent maximum density.

C. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material, to prevent free water from appearing on surface during or subsequent to compaction operations.

1. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

3.5 DECOMPACTION OF SOILS

A. General:

1. All existing in-place soil within the limit of new lawn turf and new plant beds that has been subject to compaction, vehicular traffic, equipment storage or material stockpiling prior to and during the performance of this Contract shall be deep ripped to a depth of 12 inches in accordance with the requirements of this Specification.

B. Decompaction Operations:

1. Vertically fracture all exposed subsoil material in specified areas as noted above within the Limits of Work through deep turnover and ripping, decompaction, restoring soil porosity and permeability and aiding infiltration and reducing runoff. Fracture the subsoil to a depth of 12 inches.
2. Effective fracturing of compressed subsoil material is achieved only when the soil material is moderately dry to moderately moist. Perform subsoiling only when soil has suitable moisture content as described in this Specification.
3. Contractor shall take care to stage operations of loam placement so that newly placed soils are not compacted after placement. Contractor shall demonstrate that his/her protocols for re-spreading topsoil will not cause extensive compaction.

3.6 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. Grade areas to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes, and as follows:

1. Paved areas: Shape surface of areas under paved surfaces to line, grade and cross section, with finish surface not more than 0.10 foot above or below required subgrade elevations.

C. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density for each area classification.

3.7 PROTECTION AND REPAIR

A. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

B. Repair and re-establish 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 density prior to further construction.

3.8 DISPOSAL OF UNSUITABLE AND SURPLUS EXCAVATED MATERIALS

A. Remove excess excavated materials, including unacceptable excavated material, trash and debris, and legally dispose of it off the project site.

3.9 FIELD QUALITY CONTROL

A. Quality Control Testing During Construction: Allow testing service to inspect and approve subgrades and fill layers before further construction work is performed.

B. If in the opinion of the Owner, based on testing service reports and inspection, subgrade of fills which have been placed are below specified density, provide additional compaction and testing at no additional expense.

3.10 TESTS

A. Testing laboratory will perform the following general services:

1. Determine maximum dry density and optimum moisture content of soils in accordance with standards herein before specified.
2. Provide optimum moisture - maximum density curves for undisturbed soil used for bearing and material used for compacted fill.
3. Test and approve all subgrades and compacted fill layers before construction thereon.

B. Testing laboratory will perform the following field tests:

1. Determine frequency of field tests to assure densities required. Unless otherwise determined, minimum field testing shall be a density test for each 5,000 square feet of undisturbed subgrade and for each 5,000 square feet of overlying compacted fill.

END OF SECTION

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Not Used

SECTION 32 12 16 - BITUMINOUS CONCRETE PAVEMENT

PART 1 - GENERAL

1.1 REFERENCE

A. Attention is directed to the printed form of the Contract of the City of Worcester and Division 1 of which these specifications are hereby made a part.

1.2 SECTION INCLUDES

A. Porous Bituminous Concrete Walk Paving.
B. Bituminous Concrete Roadway Paving.

1.3 RELATED WORK

A. Section 02 41 13 - Site Preparation
B. Section 03 30 00 - Cast in Place Concrete
C. Section 31 00 00 - Earthwork

1.4 REFERENCES

A. The following standards shall apply to the work of this Section.

1. ADA: Americans with Disability Act.

2. American Association of State Highway and Transportation Officials (AASHTO):
   M 20 Penetration Graded Asphalt Cement
   M 82 Cut-Back Asphalt (Medium Curing Type)
   M 140 Emulsified Asphalt

3. American Society for Testing and Materials (ASTM):
   D 1557 Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-pounds Rammer and 18-in. Drop.

4. MassDOT: "Standard Specifications for Highways and Bridges", Massachusetts Department of Transportation, latest edition.

5. Federal Specifications (Fed. Spec.):
   SS-S-1401 Sealing Compound, Hot Applied, for Concrete and Asphalt Pavements

6. General Porous Asphalt Bituminous Paving and Groundwater Infiltration Beds, specification by UNH Stormwater Center, February, 2005.

7. Design, Construction, and Maintenance Guide for Porous Asphalt Pavements, Information Series 131, National Asphalt Pavement Association (NAPA), 2003.

8. Design, Construction, and Maintenance of Open-Graded Friction Courses, Information Series 115, NAPA, 2002.

9. NAPA Porous Asphalt Seminar handout, Cahill Associates, Inc., 2004

1.5 SUBMITTALS

A. At least 30 days prior to intended use, the Contractor shall provide design mix formula (DMF) for all bituminous concrete and Type SS-1 asphalt emulsion tack coat. Do not order materials until Owner's Representative's approval of mix formula has been obtained. Delivered materials shall closely match the approved samples.

B. Submit catalog cuts and manufacturer's specifications for Airport Grade Asphalt Emulsion Mix.

C. Submit manufacturer's catalog product data, installation instructions and material safety data sheets for all specified items.

1.6 QUALITY ASSURANCE

A. Unless otherwise specified, work and materials for construction of the bituminous concrete pavement shall conform to the applicable portions of the following:

1. MassDOT Specifications Section 701 for bituminous concrete sidewalks, and Section 402 for dense graded crushed stone for base course.

B. Paving work, base course installation, top course installation and the like, shall be done only after excavation and construction work that might have damaged them has been completed. Damage caused during construction shall be repaired before acceptance.

C. Pavement subbase shall not be placed on a muddy or frozen subgrade. Pavement courses shall not be placed on frozen or contaminated base course or binder course.

D. Existing pavement under state or local jurisdiction shall, if damaged during the course of this project, be repaired or replaced as specified. Materials and construction shall match local or state paving standards and cross sections, whichever is most stringent.

E. Contractor installing porous pavement shall have a minimum of 5 years' experience in installing similar systems. The contract shall provide references for a minimum of 3 projects of similar size and nature completed within in the last three years.

1.7 TESTING AND INSPECTION

A. The Owner's Representative reserves the right to retain an independent testing laboratory to perform inspection and testing of paving and associated work in accordance with Division 1.

1.8 ADA AND UNIVERSAL ACCESSIBILITY CODE

A. Special attention is to be given to compliance with the American with Disabilities Act (ADA) and the requirements of the Universal Accessibility Code. 1. Walkway Slopes: The cross pitch (perpendicular to travel) for all pedestrian walkways of travel shall be constructed at 1.5% (2% maximum, 1% minimum). The longitudinal slope (parallel to travel) for all pedestrian walkways shall not exceed 4.5%. The slope of all handicapped curb cuts shall be constructed at 7.5% (8.3% maximum).

B. The above requirements shall supersede the grades shown on the grading plan. If the requirements cannot be met with the grades shown on the plans, the Contractor shall notify the Landscape Architect immediately.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Install bituminous concrete pavements in accordance with temperature and weather limitations specified by MassDOT.

1. No mix shall be placed on wet or damp surfaces. No mix shall be placed when ambient temperatures are 40^{O}F and falling.

1.9 GUARANTEE

A. The pavement shall be guaranteed against defects in workmanship or quality for a period of one (1) year after final acceptance. The contractor shall replace, repair, recoat or otherwise make satisfactory to the Owner's Representative any unacceptable pavement and or coating at no additional cost to the Owner's Representative.

PART 2 - PRODUCTS

2.1 BASE COURSE

A. Base course for porous walk pavement shall as specified, provided and installed Section 31 00 00 - EARTHWORK, of this Specification.

2.2 POROUS BITUMINOUS CONCRETE PAVEMENT

A. Porous Bituminous Concrete Pavement shall consist of binder mix and top courses 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, Department of Public Works, Standard Specifications for Highways and Bridges, latest edition.

B. Porous Bituminous Concrete shall be a standard plant-mixed, hot-laid paving material for walk and court work, consisting of clean, crushed rock aggregate, mineral filler, and asphalt.

1. The Contractor shall be responsible for development of all HMA mixture designs. All HMA surface courses, base courses, leveling courses shall be supported by volumetric mixture designs using the Superpave mixture design system.
2. All Superpave HMA designs shall be developed in accordance with the following AASHTO standards, as modified herein: 1. AASHTO M 323.2; 2. AASHTO R 35; 3. AASHTO T 312 OGFC and ARGG mixtures shall be designed in accordance with MassDOT Subsections M3.06.4: Hot Mix Asphalt Mixture Design, Parts G and H, respectively.

C. Porous pavement material shall be in accordance with the following:

Asphalt Materials:
Performance Graded Binder, PG70-22, or PG 76-22……. 902.01(a)
Coarse Aggregates shall be Class B or higher…….904.03
Fibers……AASHTO M 325
Fine Aggregates…….904.02

1. A Design Mix Formula (DMF) for porous pavement shall be based on OF19.0 mm open graded mixture designation in accordance with MassDOT # 401.05. The DMF shall be submitted in the current MassDOT format as a submittal. The DMF shall list the minimum plant discharge temperature for HMA and WMA as applicable to the mixture.

2. The DMF shall be determined for the porous asphalt mixture from a volumetric mix design for OG19.0 mm open graded mixture in accordance with 401.05. The DMF shall meet the following criteria:
    a. Coarse aggregates will be steel slab, limestone or crushed gravel with a crushed content of >= 90% two face and one face.
    b. Binder selection will be PG 76-22 or PG 70-22 with fibers.
    c. Air void will be >= 16% using ASTM D 6752, Vacuum Sealing method
    d. VMA should be >= 26% using ASTM D 6752, Vacuum Sealing method
    e. Draindown test will be <= 3% (open graded mixtures may incorporate fibers)
    f. Gyratory compaction shall be 20 gyrations at 260+/- 9 degrees F.

    The single percentage of aggregate passing each required sieve shall be within the following limits:

Sieve Requirement Tolerances 19.0mm	100%	-
12.5mm	70-90%	+/-5%
9.5mm	40-65%	+/-5%
4.75mm	15-30%	+/-5%
2.36mm	8-15%	+/-5%
0.60mm	5-9%	+/-2%
0.075mm	1-8%	+/-2%
Binder %	5.5% min	+/-0.7%

3. Asphalt Emulsion
    a. The tack coat shall be an asphalt emulsion, RS-1, if required, conforming to MassDOT Section M3.03.0.

2.3 BITUMINOUS CONCRETE ROADWAY PAVING

A. BASE COURSE

1. Shall be dense graded crushed stone as specified, provided and installed under Section 31 00 00, EARTHWORK, of this Specification.

B. BITUMINOUS CONCRETE

1. Roadway Bituminous Concrete shall be a standard plant-mixed, hot-laid paving material for vehicular surfaces, consisting of clean, crushed rock aggregate, mineral filler, and asphalt.

2. Bituminous Concrete Mixtures: Bituminous concrete for vehicular surfaces shall be Class I, Type I-1, furnished in accordance with MassDOT Specifications Section M3.11.03 Table A and Section 701.62.

C. BITUMINOUS MATERIALS

1. Tack coat shall consist of asphalt emulsion, Type RS-1 or RS-2 conforming to MassDOT Specifications.
2. Prime coat shall be Asphalt Primer conforming to MassDOT Specifications, M3.02.1, Asphalt Primer, and in accordance with the requirements of AASHTO M116.

2.4 TROWELABLE ASPHALT FILLER/PATCH

A. Airport grade asphalt emulsion mix and aggregate shall be used to repair gouges or cracks which can then be brought to grade to receive an overlay or color sealcoat.

2.5 GEOTEXTILE

A. Provide Geotextile material conforming to the following performance characteristics, measured per the test methods referenced:

1. 4-ounce nonwoven needle punched geotextile composed of 100% polypropylene staple fibers.
2. Grab Tensile Strength: ASTM D 4632: 115 pounds.
3. Grab Tensile Elongation: ASTM D 4632: 50%.
4. Trapezoidal Tear: ASTM D 4533: 50 pounds.
5. Puncture: ASTM D 4833: 65 pounds.
6. Apparent Opening Size: ASTM D 4751: 0.212 mm, 70 U.S. Sieve.
7. Permittivity: ASTM D 4491: 2.0 sec-1.
8. Flow Rate: ASTM D 4491: 140 gal/min/S.F.

PART 3 - EXECUTION

3.1 PLACEMENT OF GRAVEL BASE COURSE FOR PAVEMENTS

A. Areas to be paved shall be compacted and brought approximately to subgrade elevation as specified and performed under the work of Section 31 00 00 - EARTHWORK, before work of this Section is performed. Final fine grading, filling, and compaction of subgrade to receive paving, as required to form a firm, uniform, accurate, and unyielding subgrade at required elevations and to required lines, shall be specified and performed under Section 31 00 00 - EARTHWORK, of this Specification.

B. Existing subgrade material that will not readily compact as required shall be removed from the site and replaced with satisfactory materials. Additional materials needed to bring subgrade to required line and grade and to replace unsuitable material removed shall be material specified, delivered, and installed under the Section 31 00 00 - EARTHWORK, of this Specification.

C. Subgrade of areas to be paved shall be recompacted as required to bring top 8 inches of material immediately below gravel base course to a compaction of at least 95 percent of maximum density, as determined by ASTM D 1557, Method D. Subgrade compaction shall extend for a distance of at least 12 inches beyond pavement edge.

D. Excavation required in pavement subgrade shall be completed before fine grading and final compaction of subgrade are performed. Where excavation must be performed in completed subgrade or subbase subsequent backfill and compaction shall be performed as directed by the Owner’s Representative. Completed subgrade after filling such areas shall be uniformly and properly graded.

E. Areas being graded or compacted shall be kept shaped and drained during construction. Ruts greater than or equal to 2 inches deep in subgrade, shall be graded out, reshaped as required, and recompacted before placing pavement.

F. Materials shall not be stored or stockpiled on subgrade.

G. Prepared subgrade will be inspected by the Owner’s Representative. Subgrade will be

approved by the Owner's Representative before installation of paving base course. Disturbance to subgrade caused by inspection procedures shall be repaired as specified and performed under Section 31 00 00 - Earthwork, of this Specification.

H. Gravel borrow shall be furnished and installed under Section 31 00 00 - EARTHWORK, and shall be inspected prior to installation of finish pavement. Compacted gravel base course shall extend a minimum of 6" beyond where aluminum edge is installed.

3.2 INSTALLATION OF POROUS ASPHALT PAVEMENT (PAP)

A. Equipment for PAP operations shall be in accordance with 409. Fuel oil, kerosene, or other solvents shall not be transported in open containers on any equipment at ay time. Cleaning of equipment and tools shall not be accomplished on the pavement or paved shoulder areas.

B. Mix the aggregate and asphalt binder material within the established temperature range until all the materials are coated. Segregation, flushing or bleeding of Pap mixtures will not be permitted. Corrective action shall be taken to prevent the continuation of these conditions. All areas showing an obvious excess or deficiency of asphalt materials shall be removed or replaced. All mixture that becomes loose and broken, mixed with dirt, or is in any way obviously defective shall be removed and replaced.

C. Surfaces on which a PAP mixture is to be placed shall be open graded free draining aggregate and free from objectionable or foreign materials at the time of placement. Contact surfaces of curbing, gutters, manholes and other structures shall be tack coated in accordance with 406. Protect the mixture at all times from contamination by soil or other fine material during placement. Erosion controls and maintenance will be by others.

D. Do not place the mixture during weather conditions that would cause its degradation, segregation, or contamination.

E. The PAP layers will be placed in lifts with a minimum of 2 inches and a maximum of 4 inches. The mixture shall be placed upon an approved surface by means of a suitable asphalt paver. If hand work is required, keep it to a minimum. Spread the mixture in a method that produces a smooth, uniform layer before compacting. Do not haul over the mixture.

F. The PAP mixture shall be compacted with equipment in accordance with 409.03(d) immediately after the mixture has been spread and finished. Rollers shall not cause undue displacement, cracking, or shoving.

G. Compact the mixture using a minimum of two (2) passes with a 10 ton static tandem steel wheel roller (do not use the roller in a vibratory mode), completely seating the aggregate particles. Do not over compact resulting in crushed or broken aggregate. Complete rolling before mix temperatures has dropped below 250 degrees F.

H. Traffic should be restricted for 24 hours after rolling.

I. Thickness Tolerance: Ensure the placed PAP conforms to the specified thickness by randomly checking the thickness during construction. Surface Tolerance: Ensure that the finished surface is uniform and varies no more than +/- ½ inch from a 10 foot straight edge applied longitudinally to the asphalt mat.

J. Porosity Test will be performed by conducting a water hose test with five gallons per minute minimum. There should be immediate infiltration with no puddles.

3.3 INSTALLATION OF ROADWAY BITUMINOUS CONCRETE PAVING

A. Make any corrections necessary to gravel borrow furnished and installed under Section 31 00 00 EARTHWORK, to bring grades to the sections and elevations shown on the Drawings.

B. Construct bituminous concrete paving in accordance with the MassDOT Standard Specification Sections 420 and 420.60 to and including 460.68 and Section 701.65.

1. The finished surface of the top course shall be spread parallel to the bottom pavement surfaces and shall conform to the grades shown on the Drawings and to the tolerances specified in Section 460.67 of MassDOT. Surface shall be free of valleys and dips.
2. Bituminous binder and wearing surface courses shall each be applied individually, in single lifts of full thickness indicated on the Contract Documents for vehicular areas and pedestrian walks.

C. The Owner's Representative may require the Contractor to remove and replace at his own expense any defective mix not conforming to the specified job mix formula.

1. If, at any time before the final acceptance of the work, any soft, imperfect places or spots shall develop in the surface, all such places shall be removed and replaced with new materials and then compacted until the edges at which the new work connects with the old become invisible.

D. Adjacent paving, plantings and curbing wherever present shall be protected from stain and damage during entire operation. Damaged and stained areas including curbs shall be replaced or repaired to equal their original condition. Do any repair or patching to pavements outside the project site damaged by the work of the Contract.

E. Application of Tack Coat: Areas to receive tack coat prior to paving operations shall be swept clean of loose materials, dirt or other extraneous materials. Application of tack coat shall be at a rate of 0.10 gallon per square yard. The following areas shall be treated:

1. All cut edges of existing bituminous concrete pavement adjacent to placement of new paving.
2. Against all vertical structures and surfaces.
3. As a tack coat for all bituminous base courses that do not have the top course installed within a 24 hour period after placement of the base course.
4. Base surface shall be dry and clean when tack coat is applied. Bituminous paving material shall not be placed until vehicle has completely evaporated from tack coat. Adjoining new paving shall be placed before tack coat has dried or dusted over.

F. Spreading and Finishing:

1. The equipment for spreading and finishing shall be mechanical, self-powered pavers, capable of spreading and finishing the mixture true to lines, grade, width and crown by means of fully automated controls for both longitudinal and transverse slope.
2. If, during construction, it is found that the spreading and finishing equipment in use leaves tracks or indented areas, or produces other permanent blemishes in the pavement, which are not satisfactorily corrected by the scheduled operations, the use of such equipment shall be discontinued and other satisfactory spreading and finishing equipment shall be provided by the Contractor.
3. The mixtures shall be placed and compacted only at such times as to permit the proper inspection and checking by the Owner.
4. The mixtures shall be placed only upon approved surfaces that are clean from foreign

materials and dry; and when weather conditions are suitable.

5. The contact surfaces of curbing or other appurtenant structures in pavement shall be painted thoroughly with a thin uniform coating of bitumen (MassDOT Specifications RS-1) just before any mixture is placed against them. This requirement shall be included as work incidental to paving operations.
6. Machine Spreading: All mixtures shall be deposited in an approved mechanical spreader and immediately spread thereby, and then struck off in a uniform layer to the full width required and of such depth that each course, when compacted, shall have the required thickness and shall conform to the grade and cross section contour specified.
7. Hand Spreading: Spreading by hand methods will be permitted only for particular locations in the work which because of irregularity, inaccessibility or other unavoidable obstacles do not allow mechanical spreading and finishing.

G. Placing and rolling of mixture shall be as nearly continuous as possible. Rolling shall begin as soon after placing as mixture will bear the operation without undue displacement. Delays in rolling freshly spread mixture will not be permitted. Rolling shall proceed longitudinally, starting at edge of newly placed material and proceeding toward previously rolled areas. Rolling overlap on successive strips shall be greater than or equal to 1/2 width of roller rear wheel. Alternate trips of roller shall be of slightly different lengths. Corrections required in surface shall be made by removing or adding materials before rolling is completed. Skin patching of areas where rolling has been completed will not be permitted. Course shall be subjected to diagonal rolling, crossing lines of the first rolling while mixture is hot and in compactable condition. Displacement of mixture or other fault shall be corrected at once by use of rakes and application of fresh mixture or removal of mixture, as required. Rolling of each course shall be continued until roller marks are eliminated. Roller shall pass over unprotected edge of course only when paving is to be discontinued for sufficient time to permit mixture to become cold.

H. Compaction:

1. After the paving mixture has been properly spread, compaction shall be obtained by the use of power rollers of approved design and weight per inch of roller. The rollers shall be steel wheeled supplemented with pneumatic-tired rollers where required.
2. 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.
3. The densities of the completed pavement shall be not less than 95 percent of the density obtained from laboratory compaction of a mixture composed of the same materials in like proportions.

I. Portions of pavement courses which become mixed with foreign material or are in any way defective shall be removed, replaced with fresh mixture, and compacted to density of surrounding areas. Bituminous material spilled outside lines of finished pavement shall be immediately and completely removed. Such material shall not be employed in the work.

J. Joints shall present same texture, density, and smoothness as other sections of the course. Continuous bond shall be obtained between portions of existing and new pavements and between successive placements of new pavement. New material at joints shall be thick enough to allow for compaction when rolling. Compaction of pavement, base, and subgrade at joints shall be such that there is no yielding of new pavement relative to existing pavement when subjected to traffic.

K. Earth or other approved material shall be placed along pavement edges in such quantity as will compact to thickness of course being constructed, allowing at least 12 inches of shoulder width to be rolled and compacted simultaneously with rolling and compacting surface.

1. Pavement edge shall be trimmed neatly to line before placing earth or other approved material along edge.

L. Variations in pitch of finished surface shall be less than or equal to the following tolerances when tested with a 10 foot straightedge, applied both parallel to and at right angles to centerline of paved area.

1. For walk pavement surface course - 1/4 inch in 10 feet.
2. At joints with existing pavements, and at other locations where a flush transition is required, pavement elevation tolerance shall not exceed 0.01 feet.
3. At other areas pavement elevation tolerance shall not exceed ± 0.05 feet.
4. Irregularities exceeding these amounts or which retain water on surface shall be corrected by removing defective work and replacing with new material.

M. **No vehicular traffic of any kind shall be allowed to pass over the newly finished surface until it has had time to set. Seventy-two hours will be considered sufficient time for the pavement to set in most cases, but this period may be extended by the Owner's Representative as required by weather or other reasons. Under all circumstances, damage to the pavement caused by the Contractor's or public vehicles driving over the pavement before the pavement has fully cured shall be repaired as specified at no additional cost to the Owner.**

3.4 TESTING LABORATORY

A. The testing laboratory shall make the following inspections and tests: Test aggregate materials for compliance with MassDOT or furnish accepted certificate of compliance from source of supply.
1. Test bituminous concrete in accordance with MassDOT, including:
   a. Penetration Tests.
   b. Marshall Stability Tests.
   c. Voids Test.
   d. Percent of Bitumen Test.
   e. Aggregate Gradations.
   f. Certifications required by MassDOT.

2. Verify thickness of the finished bituminous pavement construction obtained from specimens cut by the testing laboratory with a core drill. The diameter of the specimens shall in no case be less than 3-7/8 inches or more than 4 inches.

B. Testing laboratory will perform the following general services:

1. Determine maximum dry density and optimum moisture content of soils in accordance with standards herein before specified.
2. Provide optimum moisture - maximum density curves.
3. Test and approve all compacted aggregate layers before construction thereon.

C. Testing laboratory will perform the following field tests:

1. Determine frequency of field tests to assure densities required. Unless otherwise determined, minimum field testing shall include one (1) density test for each 1,000 square feet.

D. If any of the above tests indicate that the Specifications have not been met, the Contractor shall pay for such additional tests as may be required to assure that compliance has been attained.

3.5 PROTECTION

A. Properly protect existing pavement and landscaping against splashing and spattering from bituminous concrete products during installation. Any materials so damaged shall be removed and replaced or satisfactorily cleaned with a pre-approved method no additional cost.

END OF SECTION

SECTION 32 14 00 - UNIT PAVING

PART 1 – GENERAL

1.1 REFERENCE

A. Attention is directed to the printed form of the Contract of the City of Worcester and Division 1 of which these specifications are hereby made a part.

1.2 SECTION INCLUDES

A. New Permeable Precast Concrete Unit Pavers, Types 1 and 2.
B. New Reinforced Turf Pavers.
C. Furnish and install all accessory items necessary for a complete installation.

1.3 RELATED WORK

A. Section 03 30 00 - Cast in Place Concrete
B. Section 04 00 00 - Masonry
C. Section 31 00 00 – Earthwork
D. Section 32 30 00 – Site Furnishings

1.4 REFERENCES

A. The following standards shall apply to the work of this Section.

1. American Association of State Highway and Transportation Officials (AASHTO):
   M 43 Standard Size of Coarse Aggregate for Highway Construction
2. American Society for Testing and Materials (ASTM):
   C 33 Specification for Concrete Aggregates
   C 136 Test Method for Sieve Analysis of Fine and Coarse Aggregates
   C 936 Specification for Solid Concrete Interlocking Paving Units
   D 1557 Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort [56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)]
3. MassDOT: "Standard Specifications for Highways and Bridges", Massachusetts Department of Transportation, Commonwealth of Massachusetts, latest edition.

1.5 SUBMITTALS

A. Samples: Samples shall be submitted for the following items:

1. Stonedust setting bed.

B. Permeable Concrete Pavers:

1. Samples for Verification for the following items: Furnish not less than three individual full-size concrete pavers of each type, size, and finish required to Owner’s Representative for approval. Samples shall exhibit the color range of approved pavers.
2 Test Results of pavers from an independent testing laboratory for compliance of concrete pavers with ASTM C 936.
3. Manufacturer’s catalog product data, installation instructions and material safety data sheets.

C. Permeable Joint Opening Aggregate:

1. Provide three representative one pound samples in containers of aggregate materials that indicate the range of color variation and texture expected upon project completion.
2. Test results from an independent testing laboratory for sieve analysis, including washed gradations per ASTM C 136.
3. Test results for void space percentage per ASTM C 29.

D. Permeable Setting Bed, Base and Subbase Aggregate:

1. Test results of samples from an independent testing laboratory for compliance with ASTM D 448 No. 8, No. 57 and No. 2.
2. Test results of samples from an independent testing laboratory for sieve analysis, including washed gradations per ASTM C 136.
3. Test results for void space percentage per ASTM C 29.

E. Paving Installation Contractor:

1. Job references shall be provided from a minimum of three projects similar in size and complexity. Provide Owner/Client/General Contractor names, postal address, phone and email address.

F. Manufacturer's Product Data: Manufacturer's product data shall be submitted for the following items:

1. Permeable precast concrete unit pavers.
2. Reinforced turf pavers.
3. Color charts for precast concrete unit pavers exhibiting full range of standard and premium colors.
4. Aluminum edging.
5. Stonedust setting bed.
6. Joint filler.

G. Test Report:

1. Test report of precast concrete paver shall be submitted.
2. Testing shall be done by an independent testing laboratory. Test procedures shall conform to ASTM C 936 methods, where applicable.
3. Test report shall indicate, as a minimum, the following:
   a. Compressive strength, pounds per square inch.
   b. Absorption, 5 hr. submersion in cold water.
   c. Absorption, 24 hr. submersion in cold water.
   d. Maximum saturation coefficient.
   e. Initial rate of absorption (suction).
   f. Abrasion index.
   g. Freeze-thaw.

1.6 QUALITY ASSURANCE

A. Installer must review installation procedures for all paver work and sequence of work with General Contractor to ensure proper coordination with other subcontractors and suppliers whose work is affected by the delivery schedule and installation of paving work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Concrete and reinforced paver units shall be packaged by strapping to manufacturer's standard and delivered on pallets. Pavers damaged in any manner will be rejected and shall be replaced with new material at no additional cost to the Owner.

B. Store all paving units on raised platforms. Storage piles or stacks shall be located to avoid or be protected from heavy or unnecessary traffic. Store paving units on wood skids or pallets. Place and stack skids and units to distribute weight evenly and to prevent breakage or cracking of units. Materials shall be stored under an approved roof or covered with non-staining waterproof tarpaulins, at all times, except when materials are being installed. Protect paving units during storage and construction against moisture, soiling, staining and physical damage.

C. Handle paving units to prevent chipping, breakage, soiling or other damage. Do not use pinch or wrecking bars without protecting edges of units with wood or other rigid materials. Lift with wide-belt type slings or vacuum lifts wherever possible; do not use wire cable or ropes containing tar or other substances which might cause staining. If required, use wood rollers and provide cushion at end of wood slides. Any paving unit chipped during delivery, storage, or handling will be rejected and replaced by the Contractor at no additional cost to the Owner.

1.8 PROJECT/SITE CONDITIONS

A. Environmental Requirements:

1. Install permeable pavers only on unfrozen permeable setting bed aggregate materials.
2. Install permeable setting bed only on unfrozen permeable base and subbase aggregates.
3. Install permeable base or subbase aggregates only over unfrozen subgrade.

1.9 PERMEABLE CONCRETE PAVER OVERAGE AND ATTIC STOCK

A. Provide a minimum of 5% additional material for overage to be used during construction.
B. Furnish 100 square feet of each product and sizes used to Owner for maintenance and repair. Furnish Permeable Concrete Pavers from the same production run as installed materials.
C. Manufacturer to supply maintenance and reinstatement manuals for Permeable Concrete Paver units.

1.10 PROTECTION OF ADJACENT SURFACES

A. Finished surfaces adjacent to the precast concrete unit paving shall be adequately protected from soiling, staining, and other damage during construction.

PART 2 - PRODUCTS

2.1 PERMEABLE PRECAST CONCRETE UNIT PAVERS

A. Concrete unit pavers shall be manufactured by Hanover Pavers, Hanover, PA, tel: 800-426-4242, or approved equal.

1. TYPE 1: “Permeable 4 x 8” pavers at 3 7/8” x 7 7/8” x 3” size with ‘Tudor’ finish, 1/16” bevel and hidden spacers in color selection by Owner’s Representative. These shall comprise 70% of total quantity.
2. TYPE 2: “Permeable 4 x 8” pavers at 3 7/8” x 7 7/8” x 3” size with ‘Natural’ finish, 1/16” bevel and hidden spacers in color selection by Owner’s Representative. These shall comprise 30% of total quantity.

B. Pavers shall be a high density, hydraulically pressed concrete units. They shall be manufactured to a tolerance of less than one-eighth inch. Unit pavers shall have a minimum compressive strength not be less than 5,000 pounds per square inch. Maximum absorption shall be 5 percent. All unit pavers shall meet or exceed ASTM specification C 936 for Solid Concrete Interlocking Paving Stones and CSA Standards for freeze-thaw performance.

1. Laminated units will not be accepted. Color matrix must be fully integrated throughout the paver units.

C. Pattern shall be herringbone with no soldier course. Alignment shall be perpendicular to the central walkway or as approved by Owner's Representative.

D. Paver colors for all types shall be chosen by Owner's Representative from the manufacturer's line of standard and premium colors.

2.2 REINFORCED TURF PAVERS

A. Reinforced turf pavers shall be manufactured by Agriculture Solutions, Kingfield, ME, tel: 888-683-8291, or approved equal.

1. Paver dimensions are: 13" x 13" x 1 ½". Paver is constructed of 100% recycled polypropylene.

2. Warranty shall be 20 years.

2.3 STONEDUST SETTING BED

A. SETTING BED for pavers shall be clean, 100% crushed slag or stone, free of twigs, glass and other foreign materials, and medium grey in color. Gradation shall conform to the following requirements:

Sieve Size	**% Passing by Weight**
#4	100
#8	60-100
#100	0-15

2.4 AGGREGATE BASE COURSE

A. AGGREGATE BASE COURSE shall conform to the requirements of Section M2.01.4 of MassDOT with 100% passing 3/4" sieve opening.

2.5 PERMEABLE JOINT OPENING AND SETTING BED AGGREGATE

A. Provide Joint Opening and Setting Bed Aggregate materials conforming to ASTM C 33 and gradation requirements of ASTM D 448 No. 8 as shown in table below:

Sieve Size	**Percent Passing**
1/2"	100
3/8"	85 to 100
No. 4	10 to 30
No. 8	0 to 10
No. 16	0 to 5

2.6 PERMEABLE BASE AGGREGATE

A. Provide Permeable Base Aggregate materials conforming to ASTM C 33 and gradation requirements of ASTM D 448 No. 57 as shown in table below:

Sieve Size	**Percent Passing**
1 ½"	100
1"	95 to 100
½"	25 to 60
No. 4	0 to 10
No. 8	0 to 5

2.7 PERMEABLE SUBBASE AGGREGATE

A. Provide Permeable Base Aggregate materials conforming to ASTM C 33 and gradation requirements of ASTM D 448 No. 2 as shown in table below:

Sieve Size	**Percent Passing**
3"	100
2 ½"	90 to 100
2"	35 to 70
1 ½"	0 to 15
¾"	0 to 5

2.8 GEOTEXTILE

A. Provide Geotextile material conforming to the following performance characteristics, measured per the test methods referenced:
1. 4 ounce nonwoven needle punched geotextile composed of 100% polypropylene staple fibers.
2. Grab Tensile Strength: ASTM D 4632: 115 pounds.
3. Grab Tensile Elongation: ASTM D 4632: 50%.
4. Trapezoidal Tear: ASTM D 4533: 50 pounds.
5. Puncture: ASTM D 4833: 65 pounds.
6. Apparent Opening Size: ASTM D 4751: 0.212 mm, 70 U.S. Sieve.
7. Permittivity: ASTM D 4491: 2.0 sec-1.
8. Flow Rate: ASTM D 4491: 140 gal/min/S.F.

2.9 JOINT FILLER

A. Joint filler shall be a clean, washed, uniformly well graded masonry sand with 100 percent passing No. 16 (1.18-mm) sieve and no more than 10 percent passing No. 200 (0.075- mm) sieve, conforming to ASTM C 144, except that the fineness modulus shall be 2.25+ 0.10. Sand shall be from a single source. Source of supply shall not be changed during course of job without written permission of the Architect.

B. Color of sand shall be uniform matching the paver in color, and shall be approved by the Architect.

2.10 UNIT PAVER EDGE RESTRAINT

A. Edge restraint shall 'BrickBlock' as provided by Permaloc, tel: 800-356-9660, or approved equal. The edge restraint shall meet the following specifications:
a. Material: Aluminum.

b. Finish: “Black Duraflex”.
c. Dimensions: 3/16" X 2 3/4".
d. Grade: Heavy Duty.
e. Installation Method: 10" galvanized common spikes.

PART 3 – EXECUTION

3.1 PLACEMENT OF AGGREGATE BASE COURSE FOR PAVEMENT

A. Construct base course as detailed on the Drawings for all areas of new paved surfaces in this Section. Make any corrections necessary to base materials furnished and installed under Section 31 00 00 – Earthwork, to the sections and elevations shown on the Drawings.

B. Spread aggregate from self-spreading vehicles, approved type of power grader or by hand upon prepared subgrade. Spread evenly in layers so as to avoid separation of aggregates. Layers shall not exceed 6 inches in depth after compaction. Remove stones larger than 3 inches. When spread, rolled and compacted on the prepared surface, it shall form a stable surface. All rolling shall be done with a roller weighing 8 to 10 tons. Compact any portion which is not accessible to a roller by mechanical or hand tamper. Compact to 95% Proctor Density.

C. Final rolled surface shall be true to the lines and grades indicated on the Drawings or as directed by the Owner’s Representative. Fill in any depression that may appear during and after rolling with aggregate and reroll until the surface is true and even.

D. Tolerance: 1/4 inch maximum above or below the cross-section grades and 1/4 inch maximum under a 10-foot line longitudinally.

E. Maintain the surface of any layer in its finished condition until succeeding layer is placed.

3.2 INSTALLATION OF STONEDUST SETTING BED

A. The setting bed shall be placed and leveled to provide a uniform bedding plane parallel to the finished pavement surface. The bed material shall be leveled to a surface tolerance of plus or minus 3/16 inch giving a compacted thickness of 1 inch. The leveled course will be compacted with a light vibratory roller. The compacted bed material shall then be leveled again to a depth of 1 inch.

B. Care shall be taken to ensure the setting bed is not disturbed in any way. If the setting bed is accidentally disturbed by walking or rain, then rake and re-level as described above.

C. Do not level more setting bed area then the area of pavers which can be set that day.

3.3 PAVER INSTALLATION ON SETTING BED

A. General: Pavers shall be installed immediately after installation of setting bed. Paver installation shall be plumb, level and true to line and grade and shall coincide and align with adjacent work and elevations. Care shall be taken during the layout to minimize cutting.

1. Paving of each area shall proceed from one side or end; installation shall not commence from opposite ends or sides. The pavers shall be placed in straight courses.
2. Starting at paver layout baselines, commence laying the pavers on the undisturbed setting bed in the pattern and color as shown on the Drawings.
3. Pavers shall be installed hand tight with maximum joints as follows: 1/16" (hand tight) joint.

4. String lines shall be used frequently to hold pattern lines true and accurate. Maximum deviation for joints from a straight line will not exceed 1/8 inch in 10 feet.

B. Cut pavers as required with high-speed masonry saw to provide clean, sharp edges and as required to fit neatly around all projections. Lay out coursing so that at end conditions no paver will have to be cut to a width of less than 2 inches. Cut as required to provide pattern shown and to fit new adjoining work neatly. Place pavers in the pattern indicated on the Drawings and with uniform top surface and alignment. Protect newly laid pavers at all times from damage or stain.

C. All cutting and patching required to complete the work shall be done (including the filling and closing of all openings) with water-cooled radial cut-off type masonry saws with diamond-tipped blade for a sharp, straight edge. Cut edges shall be plumb and straight. Scoring and breaking will not be acceptable.

D. Install paver edge restraints in accordance with the drawings and manufacturer’s recommendations. Provide corners and angles in continuous sections.

1. Aluminum edging shall be securely staked in required position. Stakes shall be driven every 12 inches on center in straight runs. Punch edging as required for anchoring.
2. Adjacent lengths shall be attached using manufacturer's standard connections according to manufacturer's published instructions.
3. Edging shall be set plumb and vertical at required line and grade. Straight sections shall not be wavy.

E. Full units shall be laid first and cuts done subsequently. All pavers requiring cutting shall be saw-cut. Pavers abutting gutters, building faces, utility surface expressions or vertical elements are to fit around these objects with a maximum of 1/4-inch joint. Cut pavers are to be no smaller than 3 inches in any dimension on pedestrian areas. Where field cutting would result in pavers below these minimum sizes, use larger pavers adjacent to fill space. All units are to fit together accurately.

F. Installers shall lay subsequent pavers by moving forward on the top of the previously installed units.

G. Do not use unit pavers with chips, cracks, voids, discolorations or other defects which might be visible or cause staining in the finished work. Keep exposed surfaces free of mortar and other deleterious substances at all times. No cracked, broken or chipped pavers will be allowed in the finished work.

H. Newly laid pavers shall be protected at all times by panels of plywood on which the installer stands. These panels can be advanced as work progresses. These precautions must be taken in order to avoid depressions and protect paver alignment. All necessary precautions shall be taken in order to avoid depressions and protect paver alignment.

I. On recommencement of laying operations, the edge of two courses of existing paving shall be lifted and the sand re-screeded before further pavers are laid.

J. After a sufficient area of pavers has been installed, joints of pavers shall be filled by sweeping joint filler into the joints.

K. Completed surface shall be compacted by running a medium plate vibrator across the top of the pavers. Additional joint filler material shall be swept in the joints during vibration to completely fill joint space.

L. Prior to acceptance, the paved area shall be flooded with water to assure that there are no depressions. Pavers with top surfaces greater than 1/16 inch above or below adjacent pavers shall be removed and reset. Remove and reset pavers as required until surface is true to line and grade. Refill sand in joints as necessary until all joints are filled to finish grade.

M. Install paver edge restraints in accordance with the drawings and manufacturer's recommendations. Provide corners and angles in continuous sections. Anchor edge restraints at 12" O.C. spacing maximum. Punch edging as required for anchoring. Install aluminum edging with the bottom leg sitting on the base course with the upper leg facing toward the unit paver edge. Set aluminum edging to the required alignment, straight and true and to the required elevation to ensure full paver restraint. Thread spike through insulating washer. Drive spikes into base course until spike head firmly wedges washer against flange of aluminum edging.

N. After a sufficient area of pavers has been installed, joints of pavers shall be filled by sweeping sand into the joints according to manufacturer's directions.

3.4 EXAMINATION FOR PERMEABLE PAVER INSTALLATION

A. Examine areas indicated to receive paving for compliance with requirements for installation tolerances and other conditions affecting performance for the following items before placing the Permeable Concrete Unit Pavers.

1. Verify that subgrade preparation, compacted density and elevations conform to the specified requirements.

3.5 PREPARATION

A. Verify that the subgrade soil is free from standing water.

B. Stockpile Permeable Setting Bed, Jointing Material, Base and Subbase Aggregate materials such that they are free from standing water, uniformly graded, free of any organic material or sediment, debris, and ready for placement.

C. Remove any excess thickness of soil applied over the excavated soil subgrade to trap sediment from adjacent construction activities before placing the Geotextile and Permeable Subbase Aggregate materials.

D. Keep area where pavement is to be constructed free from sediment during the entire job. Remove and replace all Geotextile, Permeable Joint, Setting Bed, Base and Subbase Aggregate materials contaminated with sediment with clean materials.

E. Base compaction and proof-rolling of the subgrade soil will be on the recommendations of the Owner's Representative.

3.6 INSTALLATION

A. GEOTEXTILES: Provide separation geotextile on the bottom and sides of the prepared soil subgrade. Secure in place to prevent wrinkling or folding from equipment tires and tracks.

1. Overlap ends and edges a minimum of 18 inches in the direction of drainage.

B. PERMEABLE BASE AND SUBBASE AGGREGATE

1. Provide the Permeable Subbase Aggregate in uniform lifts not exceeding 6 inches, loose thickness and compact to at least 95 percent as per ASTM D 4254 to depths as indicated.
2. Compact the Subbase Aggregate materials with at least two passes in the vibratory roller until there is no visible movement. Do not crush aggregate with the roller.
3. Tolerance: Do not exceed the specified surface grade of the compacted Subbase Aggregate material more than +/- ¾" over a 10 foot long straightedge laid in any direction.
4. Provide the Base Aggregate material in uniform lifts not exceeding 6 inches over the Subbase Aggregate materials and compact to at least 95 percent as per ASTM D 4254 to depths indicated.
5. Compact the Base Aggregate material with at least two passes in the vibratory mode then at least two In the static mode with a minimum 10 ton vibratory roller until there is no visible movement. Do not crush the aggregate with the compaction device.
6. Tolerance: Do not exceed the specified surface grade of the compacted Base Aggregate material more than ½" +/- over a 10 foot long straightedge laid in any direction.
7. Grade and compact the upper surface of the Base Aggregate material sufficiently to prevent infiltration of the Setting Bed Aggregate material both during construction and throughout its service life.

C. PERMEABLE SETTING BED AGGREGATE

1. Provide, spread and screed the Permeable Setting Bed aggregate evenly over the Base Aggregate course.
   a. Protect the screeded Setting Bed Aggregate from being disturbed.
   b. Screed only the area which can be covered by pavers in one day.
   c. Do not use Setting Bed Aggregate material to fill depressions in the base surface.
   d. Keep moisture content constant and density loose and constant until unit pavers are set and compacted.
   e. Acceptance of the Setting Bed Aggregate occurs with the initiation of Permeable Concrete Paver placement. Proceed with installation only after unsatisfactory conditions have been corrected.

3.7 FIELD QUALITY CONTROL

A. Verify final elevations for conformance to the Drawings after sweeping the surface clean. Prevent final concrete paver finished grade elevations from deviating more than 3/8" +/- under a 10 foot straightedge for finished surface of paving.

B. Paver to Paver Lippage:

1. No greater than 1/8 inch difference in height between adjacent pavers shall be allowed.

3.8 REPAIRING AND CLEANING

A. After completion of concrete paving, surfaces shall be carefully cleaned, removing all dirt, grout, sand and stains using an approved masonry cleaner and soft bristle brush.

B. Remove and replace unit pavers that are loose, chipped, broken, stained or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

C. Cleaning: Remove excess dirt, debris, stains, grit etc. from exposed paver surface. Wash paver unit and scrub clean according to manufacturer's written recommendations.

3.9 PROTECTION

A. Protect completed work from damage due to subsequent construction activity on the site.

3.10 CLEANING OF PRECAST CONCRETE UNIT PAVER SURFACES

A. After completion of precast concrete unit paving, surfaces shall be carefully cleaned, removing all dirt, grout, sand and stains using an approved masonry cleaner and soft bristle brush.

END OF SECTION

SECTION 32 30 00 - SITE IMPROVEMENTS

PART 1 - GENERAL

1.1 REFERENCE

A. Attention is directed to the printed form of the Contract of the City of Worcester and Division 1 of which these specifications are hereby made a part.

1.2 SECTION INCLUDES

A. Furnish and install the following site improvements:

1. New Benches
2. New Trash and Recycling Receptacles
3. New Tables and Seats
4. New Bike Racks
5. New Precast Concrete Light Pole Foundations
6. New Entrance Sign
7. Reinstall Existing Pollinator Signs

B. Furnish and install all accessory items including hardware, connecting angles, clip angles, bolts, welds, bracing members, etc. necessary for a complete installation.

1.3 RELATED WORK

A. Section 02 41 13 - Site Preparation
B. Section 03 30 00 - Cast in Place Concrete
C. Section 26 00 00 - Electrical
D. Section 31 00 00 - Earthwork
E. Section 32 12 16 - Bituminous Concrete Paving
F. Section 32 14 00 – Unit Paving

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect and handle materials, during loading, shipping, unloading at the site, storage and erection as required to prevent damage to finish surfaces, section contours, squareness, straightness and flatness of fabricated members

1.5 DEFECTIVE MATERIALS

A. Do not install defective materials. No patching or hiding of defects will be permitted. Refer to Owner’s Representative for decision on all materials showing flaws or imperfections upon delivery to the job site. The Owner’s Representative's decision as to rejection of materials shall be understood to be final. Remove rejected material from the site and replace with new material.

1.6 REFERENCES

American Standards for Testing Materials, latest edition; Standards A-120, VA569, 1487-98 (S), and A-500 (ASTM).

Standard Steel Composition, Society of American Engineers

Standard Steel Composition, American Iron and Steel Institute

American Steel Institute (ASI), Standards for Structural Steel, latest edition.
Standards for Welding, American Welding Society, (AWS).

Specifications for Thermal Galvanizing

Structural Steel Painting Council SSPC-SP-5, SSPC-SP-10

American Society of Testing and Materials ASTM D-4417

City of Worcester Department of Public Works and Parks, Standard Specifications, latest edition.

1.7 QUALITY ASSURANCE

A. Construction Tolerances:

1. Variations from plumb: 1/4 inch in 10 feet.
2. Variations from level: 1/4 inch in 20 feet.
3. Variation of linear line: 1/2 inch in 20 feet.
4. Variations from slope as indicated for finished surface of paving: 1/4 inch in 10 feet.
5. Variations from flush in unit to unit offset: 1/32 inch.

B. Precast Quality Control:

1. Fabricator must be designated a PCI Certified Plant for Group A1 - Architectural Concrete.
2. Quality Control Testing: test and inspect precast concrete as determined by Owner, according to MNL-117 requirements.
3. Strength of precast concrete units will be considered deficient when they fail to comply with ACI 318 [ACI 318M] requirements.
4. Defective Work: Discard precast concrete units that do not conform to requirements including strength, manufacturing tolerances and finishes. Replace with precast concrete units that meet requirements.
5. Precast design modifications may be made only as necessary to meet field conditions and to insure proper fitting of the work and only as acceptable to Owner. Maintain general design concept shown without increasing or decreasing sizes of members or altering profiles and alignment shown.
6. Installer Qualifications: Engage an experienced Installer who has completed similar architectural precast concrete work similar in material, design and extent to that indicated for this project and with a record of successful in-service performance.
7. Do not change source of sources for precast concrete or setting materials during progress of work.

1.8 SUBMITTALS

A. Manufacturer's catalog data and specification sheets for each type of manufactured product, including certification that each product complies with specified requirements. Include instructions for handling, storage, installation and protection.

B. COLOR SAMPLES: Submit manufacturer’s standard color samples for site furnishings.

C. Shop Drawings for all signs shall be submitted for approval prior to start of fabrication.

1. Manufacturer’s technical data and installation instructions for each type of sign required.

2. Shop drawing for signs enumerating the various dimensions of all sign sections to be constructed as well as letter font and letter heights, and typical post, hardware and footing details.

3. Samples for signage material:

   a. All materials to be used, approximately 6 inches square, showing finish.

4. Full size positive of art work for a camera-ready graphic including sign layout with typography.

D. Submittals for precast concrete foundations shall include:

1. Concrete design mix including report on design strength test.

2. Test reports on materials evidencing compliance with requirements:

   a. Tests of materials, or review of test reports available from suppliers. Submit material certificates in lieu of agency test reports, when permitted by Owner’s Representative, signed by fabricator certifying that each material item complies with requirements.

3. Shop drawings shall include sizes, shapes, finishes and location of materials, reinforcing, relations to adjacent construction and proposed light poles. Include locations and details of hoisting points and lifting devices for handling and erection.

E. Certificates of Compliance: Submit Certificates of Compliance from fabricator and coating manufacturer indicating compliance with requirements of specifications prior to application for payment.

F. Warranties: Submit written warranties from precast concrete light pole bases and site furnishing manufacturers to the Owner’s Representative.

1.9 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handle and ship all items so as to prevent damage in transit. Use only material that is not subject to staining or discoloration for blocking and packing. Deliver materials to site in manufacturer's original containers with labels intact and seals unbroken.

B. Unload and handle all items carefully so as to prevent chipping and breakage. Protect all items during handling, storage and construction against moisture, soiling, staining and physical damage. Store on wood skids or pallets, covered with non-staining, waterproof membrane. Place and stack to distribute weight evenly and to prevent breakage or cracking. Protect stored materials from weather with waterproof, non-staining covers or enclosures, but allow air to circulate around materials. Replace materials damaged in any manner.

C. Locate storage piles, stacks or bins to avoid and be protected from heavy and unnecessary traffic.

1.10 MAINTENANCE MATERIALS

A. Provide Owner with not less than two sets of tools required for removing and replacing vandal resistant hardware.

B. Spare Parts:
1. Hardware: 2 of each type.

PART 2 - MATERIALS

2.1 SITE FURNISHINGS

A. BENCHES: shall be Model #117-60 as manufactured by Dumor, Mifflintown, PA.

1. Materials:
    a. Supports:
        i. End Supports shall be manufactured from 2” x 2” x 11 gauge ASTM A513 steel tubing.
    b. Seat Assembly:
        i. Seat assembly shall be manufactured from 1” x 2” 13 gauge ASTM A513 steel tubing, 1/4” thick ASTM A36 steel plate and 3/8” thick ASTM A36 steel plate.
    c. Anchoring:
        i. Provide Stainless steel expansion anchors (1/2” x 3 3/4”) in quantity necessary to properly secure the bench at every anchor point.
2. Dimensions:
    a. 72” long x 26 7/16” deep x 36 3/16” high
3. Finish:
    a. Powder Coating
        i. All parts are processed through an 8-stage iron phosphorous wash system.
        ii. Parts are coated with a zinc-rich epoxy primer to an AVERAGE of 4-5 mils.
        iii. Parts are then finished with a top coat of TGIC-polyester powder to an AVERAGE of 4-5 mils.
        iv. Powder is cured at the powder manufacturers specifications using combination of infrared and convection heat for approximately 20 minutes.
        v. Finished parts shall comply with the following American Standard Test Method (ASTM) for coating and coating method: ASTM-D-523, ASTM-D-3363, ASTM- ASTM-D-1737, ASTM-D-3359, ASTM-D-2794, ASTM-B-117 and ASTM-D-3451.
4. Provide (11) benches.

B. TRASH AND RECYCLING RECEPTACLES: shall be #107-32, manufactured by Dumor Inc, Mifflintown, PA.

1. All new receptacle installations shall be surface mounted on a cement concrete pad as shown on Drawings.
2. Receptacle body shall be manufactured from 3/8” x 1 1/4” ASTM A36 carbon steel flat bar, 3/8” x 1 1/4” ASTM A36 carbon steel flat bar, 1/4” x 3” ASTM A36 carbon steel flat bar, 5/8” diameter ASTM A36 steel round bar and 1/4” thick ASTM A36 steel plate.
3. Cover shall be manufactured from 14 gauge ASTM A1011 steel plate.
4. Receptacles shall come with anchor bolts for surface mounting and a 32 gallon plastic liner.
5. Recycling receptacle shall come with a spun shield with the word ‘Recycling’ spelled out on top surface. Color of shield shall be selected by Owner’s Representative.
6. Finish:
    a. Powder Coating
        i. All parts are processed through an 8-stage iron phosphorous wash system.
        ii. Parts are coated with a zinc-rich epoxy primer to an AVERAGE of 4-5 mils.

iii. Parts are then finished with a top coat of TGIC-polyester powder to an AVERAGE of 4-5 mils.
iv. Powder is cured at the powder manufacturers specifications using combination of infrared and convection heat for approximately 20 minutes.
v. Finished parts shall comply with the following American Standard Test Method (ASTM) for coating and coating method: ASTM-D-523, ASTM-D-3363, ASTM-D-1737, ASTM-D-3359, ASTM-D-2794, ASTM-B-117 and ASTM-D-3451.

7. Provide (2) trash receptacles and (2) recycling receptacles.

C. TABLES AND SEATS: shall be #A-I-424, provided by Victor Stanley, Dunkirk, MD or approved equal.

1. Table and seats shall be steel shotblasted, etched, phosphatized, preheated and electrostatically powder-coated with TGIC polyester powder coatings. Mounting shall be in-ground embedded in concrete footings.
   a. Tables shall be 42” in diameter with a perforated top, “Round” pattern.
   b. Seats shall be 18-1/2” x 15-1/2” at their maximum and constructed of horizontal metal slats with a fully welded steel skirt.
2. Provide the following:
   a. Provide (2) ADA accessible units comprised of one table and three seats.
   b. Provide (2) standard units comprised of one table and four seats.

D. BIKE RACKS: shall be the Hoop Rack by Dero, Minneapolis MN, tel: 888-337-6729, or approved equal.

1. Bike racks shall be surface mounted to new concrete pads.
2. Bike racks shall have a powdercoat finish.
3. Provide (3) complete bike racks.

2.2 PRECAST CONCRETE LIGHT POLE BASES

A. Precast light pole bases shall be fabricated from air-entrained concrete conforming to the requirements and applicable provisions of M4.02.0 of MassDOT Standard Specifications. Minimum 28-day compressive strength is 4,000 psi.

1. Cracked, broken, spalled, stained or otherwise defective precast units are not acceptable.
2. Bases shall be reinforced with twelve (12) - #5 rebars placed vertically, equally spaced, and #3 ties at 8” on center.
3. Air entrainment is 6 – 7% minimum with a 2 – 4” maximum slump.

B. Acceptable manufacturers of new precast pole bases are: E. F. Shea New England Concrete Products, Inc., Wilmington MA, tel: 978-658-2645; Precast Specialties Corp., Abington MA, tel: 781-878-7220; Scituate Companies, Marshfield MA, tel: 800-440-0009; or approved equal.

C. Fabricate precast concrete units complying with manufacturing and testing procedures, quality control recommendations and following dimensional tolerances unless otherwise indicated.

1. Fabricate precast concrete units according to the approved Shop Drawings. Exposed edges and corners shall be precise, square and true unless otherwise indicated. Provide uniformly chamfered edge and corner treatment. Bases shall be smooth and true to size and shape.

2. Exposed surfaces: Steel trowel or polished top surface and sandblast finish other surfaces with a light sugar cube finish, all free of pockets, sand streaks and honeycomb with uniform color and texture.

D. Provide (10) complete light pole bases with all required hardware and appurtenances.

2.3 PARK SIGN

A. PARK SIGN shall be constructed of two .21 mm aluminum panels bonded to a solid polyethylene core. Sign shall be mounted between two tubular square steel posts as supplied by FastSigns of Worcester MA, tel: 508-841-5800, or approved equal. Signs shall be printed with graphics and shall have a 5 year warranty.

1. Sign shall be mounted with inside an anodized aluminum frame that encases all sides of the sign.
2. Aluminum frame shall be connected to steel posts with stainless steel brackets.
3. Overall thickness of ACM panel is 6 mm.
4. Graphics for the sign shall be provided by the Owner’s Representative. Sign shall be a full color digital print with a UV laminate for color protection.
5. Steel posts shall be galvanized and painted black. Posts shall be anchored in the ground in concrete footings. Posts shall be fitted with a cast iron finial sphere cap for 3” square posts.
6. Color for the back of sign and frame shall be selected by the Owner’s Representative.

B. Concrete for footings shall comply with Section 03 30 00 – CAST-IN-PLACE CONCRETE.

C. Provide (1) complete sign installation with all required hardware and appurtenances.

2.4 MISCELLANEOUS MATERIALS

A. CONCRETE FOR FOOTINGS shall conform to ASTM C94 using 3/4-inch maximum size aggregate and have a minimum compressive strength of 3,000 psi at 28 days.

B. EPOXY GROUT shall conform to ASTM C-881 and equal to "Sikadur 32, Hi-Mod" high strength adhesive as manufactured by Sika Corporation, Lyndhurst NJ, or approved equal.

C. Existing pollinator signs that were salvaged shall be reinstalled in locations as determined by Owner’s Representative.

PART 3 - EXECUTION

3.1 INSTALLATION OF SITE IMPROVEMENTS - GENERAL

A. Assemble and install site improvements in accordance with the Drawings and manufacturer's written instructions as required.

B. Fasten items securely together by anchoring and fastening as shown and as required by recognized standards. Make tight connections between members. Discard units of material with defects which might impair quality of work, and units which are too small to use in fabricating work with minimum joints or optimum joint arrangement.

C. Install epoxy and sealants in strict accordance with manufacturer's written instructions.

D. Repair damaged surfaces and finishes after completion of installation, or replace damaged members as directed where damage is beyond satisfactory repair.

E. Perform all excavation of every description and through whatever materials encountered to the depths indicated on the Drawings. In all other respects excavation shall conform to the requirements of Section 31 00 00 – Earthwork of these Specifications.

F. Perform all work by workmen skilled and experienced in the trade in a neat and clean fashion. Install all work in accordance with the Drawings in straight and true lines, plumb and true to line and grade.

3.2 INSTALLATION OF SITE FURNISHINGS

A. Assemble and install site furnishings in accordance with the Drawings and manufacturer's recommendations in a neat and clean fashion. Install benches in straight and true lines, plumb and true to line and grade. Secure in place. Install furnishings with the top of benches and trash receptacles horizontal and square to paving unless otherwise shown on the Drawings.

B. Site furnishings shall be firmly secured to new concrete pads with stainless steel expansion anchors.

1. Neatly drill or core into paving and set anchor in non-shrink epoxy grout.
2. Install epoxy and sealants in strict accordance with manufacturer's written instructions.

C. Repair damaged surfaces and finishes after completion of installation, or replace damaged members as directed where damage is beyond satisfactory repair.

D. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation of miscellaneous metal fabrications. Set work accurately in location, alignment, elevation, level, true and free of rack, measured from established lines and levels.

E. Provide all temporary bracing, guy wires, turnbuckles, horizontal struts, etc., as may be required to plumb and hold the metal fabrications in place and aligned at all times during assembly and to take care of all lateral and vertical loads to which the work may be subjected. Provide temporary bracing or anchors in formwork for items which are built into concrete, masonry or similar construction.

F. Do not field modify any shop assembly unless approved by Owner’s Representative.

3.3 CONCRETE FOOTINGS

A. FOOTING EXCAVATION: Drill holes for footings in firm, undisturbed or compacted soil of diameters and spacings shown. Excavate holes to the minimum diameters or at least 3 times the diameter of the post. Excavate hole depths approximately 6" lower than the post bottom, with bottom of posts set not less than 48" below the surface when in firm, undisturbed soil. Remove excess excavated material from the site. Where ledge is encountered, the Contractor shall notify the Owner’s Representative to determine method of installation.

B. CONCRETE STRENGTH: Allow concrete to attain at least 75% of its minimum 28 day compressive strength, but in no case sooner than 7 days after placement, before additional weight is installed.

3.4 PRECAST FOUNDATION INSTALLATION

A. EXCAVATION: Drill holes for precast foundations in firm, undisturbed or compacted soil of dimensions and spacings shown, or as recommended by manufacturer. Unless otherwise indicated, excavate hole depths approximately 3" lower than the footing bottom, with bottom of footing set not less than 48" below the surface when in firm, undisturbed soil. Excavate deeper as required for adequate support in soft and loose. Remove excess excavated material from the site.

B. The Contractor shall be responsible for timing the delivery of light poles so as to minimize on-site storage time prior to installation. All stored materials must be protected from weather, careless handling and vandalism.

C. Install new light poles in new precast concrete foundations in accordance with the Drawings and the manufacturer’s instructions and recommendations.

3.5 SIGN INSTALLATION

A. The installer shall examine 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 the work means that installer accepts substrates, and conditions.

1. Posts for all signs shall be set plumb in new concrete footings when viewed from all directions. Sign shall be level.

3.6 TOUCH-UP AND REPAIR

A. Touch Up Painting: Immediately after erection of steel components, clean field welds, bolted connections, abraded areas and surfaces to which paint was omitted for field welding and paint exposed areas with same material as used for shop painting to comply with SSPC-PA1 requirements for touch up of field painted surfaces.

1. Apply by brush or spray to provide the required minimum dry film thickness.

3.7 CLEANING AND PROTECTION

A. Protect materials, fabrications, and assemblies with metal coatings from damage during construction using methods approved by fabricator and coating manufacturer.

B. Protect work in progress and after completion. Keep the premises neat and clean at all times.

END OF SECTION

SECTION 32 31 19 - DECORATIVE METAL FENCE

PART 1 – GENERAL

1.1 REFERENCE

A. Attention is directed to the printed form of the Contract of the City of Worcester and Division 1 of which these specifications are hereby made a part.

1.2 SECTION INCLUDES

A. The contractor shall provide all labor, materials and appurtenances necessary for repair of an existing manufactured steel fence system defined herein, installation of new manufactured steel gate, and repair of the existing steel fence system.

1.3 RELATED WORK

A. Section 03 30 00 - Cast in Place Concrete

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Upon receipt at the job site, all materials shall be checked to ensure that no damage occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage, and to protect against damage, weather, vandalism and theft.

1.5 DEFECTIVE MATERIALS

A. Do not install defective materials. No patching or hiding of defects will be permitted. Refer to Owner’s Representative for decision on all materials showing flaws or imperfections upon delivery to the job site. The Owner’s Representative's decision as to rejection of materials shall be understood to be final. Remove rejected material from the site and replace with new material.

1.6 QUALITY ASSURANCE

A. The contractor shall provide laborers and supervisors who are thoroughly familiar with the type of construction, materials and techniques involved with this work.

1.7 REFERENCES

ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
ASTM B117	Practice for Operating Salt-Spray (Fog) Apparatus.
ASTM D523	Test Method for Specular Gloss.
ASTM D714	Test Method for Evaluating Degree of Blistering in Paint.
ASTM D822	Practice for Conducting Tests on Paint and Related Coatings and Materials using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus.
ASTM D1654	Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.

ASTM D2244	Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.
ASTM D2794	Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
ASTM D3359	Test Method for Measuring Adhesion by Tape Test.
ASTM F2408	Ornamental Fences Employing Galvanized Steel Tubular Pickets.

1.8 SUBMITTALS AND WARRANTIES

A. Manufacturer's catalog data and specification sheets for each type of manufactured product, including certification that each product complies with specified requirements. Include instructions for handling, storage, installation and protection.

1. Samples: Submit samples of any materials requested by Owner’s Representative.

B. SHOP DRAWINGS

1. Submit shop drawings of all locations of metal picket fencing and gate showing elevations, materials, heights and sizes, attachments, and anchoring to in-place construction.

C. PRODUCT WARRANTIES: Submit written warranties from fabricator as follows:

1. Special Project Warranty by fabricator agreeing to repair or replace fabrications that fail in materials or workmanship due to non-compliance with specified requirements. Repair and replacement costs shall include labor, materials and overhead. Failure is defined as embrittlement, distortion, or warpage. Warranty period begins at date of fabrication and extends until 2 years after the date of Substantial Completion.
2. All structural fence components (rails, pickets, and posts) shall be warranted within specified limitations, by the manufacturer as stated in the product warranty. Warranty shall cover any defects in material finish, including cracking, peeling, chipping, blistering or corroding.
3. Reimbursement for labor necessary to restore or replace components that have been found to be defective under the terms of manufactures warranty shall be guaranteed for five (5) years from date of original purchase.

1.9 PROJECT CONDITIONS

A. Field Measurements: Check by accurate field measurements the actual layout and dimensions of the new concrete stair foundation and other construction to which existing granite treads must fit. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of work.

B. Where field measurements cannot be made without delaying the work, guarantee dimensions and proceed with fabrication of products without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

PART 2 – MATERIALS

2.1 MANUFACTURER

A. The new metal pedestrian gate and any repair components shall match the existing fence system. Fence system has a standard picket air space of 3 15/16" maximum.

B. The manufacturer shall supply a total fence system including all components (i.e., panels, posts, gates and hardware) required.

2.2 MATERIAL FOR FENCING AND GATES

A. Steel material for fence panels and posts shall conform to the requirements of ASTM A653/A653M, with a minimum yield strength of 45,000 psi and a minimum zinc hot-dip galvanized coating weight of 0.60 oz/ft^2, Coating Designation G-60.

B. Material for pickets shall be 3/4" square x 18 gauge tubing. The rails shall be steel channel, 1.5" x 1.4375" x 14 Ga. Picket holes in the rail shall be spaced at 4.675" OC.

C. Fence posts for all fence heights shall be 2 1/2" square x 14 Gauge minimum.

D. Gate Materials:

1. Gate posts shall be 2 ½" square x 14 Gauge minimum.
2. Gate frame shall be 1 3/4" square steel channel.
3. Gate pickets shall be 3/4" square x 18 Gauge tubing.
4. Gate latch shall match existing.
5. Latch shall be equipped with a fob for combination lock.

2.3 FABRICATION

A. Pickets, rails and posts shall be pre-cut to specified lengths. Rails shall be pre-punched to accept pickets.

B. Pickets shall be inserted into the pre-punched holes in the rails and shall be aligned to standard spacing using a specially calibrated alignment fixture. The aligned pickets and rails shall be joined at each picket-to-rail intersection by a fusion welding process.

C. The manufactured panels and posts shall be subjected to an inline electrode position coating process consisting of a multi-stage pretreatment/wash, followed by a duplex application of an epoxy primer and an acrylic topcoat. The minimum cumulative coating thickness of epoxy and acrylic shall be 2 mils. The coated panels and posts shall be capable of meeting the performance requirements for each quality characteristic shown in Table 1.

1. The finish coat color shall be black.

D. The manufactured fence system shall be capable of meeting the vertical load, horizontal load, and infill performance requirements for residential weight fences under ASTM F2408.

Table 1 – Coating Performance Requirements

Quality Characteristics	ASTM Test Method	Performance Requirements
Adhesion	D3359 – Method B	Adhesion (Retention of Coating) over 90% of test area (Tape and knife test).
Corrosion Resistance	B117, D714 & D1654	Corrosion Resistance over 1,000 hours (Scribed per D1654; failure mode is accumulation of 1/8” coating loss from scribe or medium #8 blisters).
Impact Resistance	D2794	Impact Resistance over 60 inch lb. (Forward impact using 0.625” ball).
Weathering Resistance	D822, D2244, D523 (60° Method)	Weathering Resistance over 1,000 hours (Failure mode is 60% loss of gloss or color variance of more than 3 delta-E color units).

PART 3 – EXECUTION

3.1 PREPARATION

A. All new fence and gate installation shall be laid out by the contractor in accordance with the construction plans.

3.2 FENCE INSTALLATION

A. Post to post spacing shall not exceed 8’ maximum.

B. Fence panels shall be attached to posts with brackets supplied by the manufacturer. Refer to Section 31 00 00 – Earthwork for base preparation requirements and Section 03 30 00 – Cast In Place Concrete for concrete footer requirements.

3.3 GATE INSTALLATION

A. New and existing gate and gate posts shall be installed according to manufacturer’s directions. Attach hardware so as to have the tamper-proof nuts inside the property, which will prevent unauthorized removal.

B. Adjust hardware for smooth operation and lubricate where necessary to operate smoothly, easily, and quietly, free from binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

3.4 FENCE INSTALLATION MAINTENANCE

A. When cutting/drilling rails or posts adhere to the following steps to seal the exposed steel surfaces:

1. Remove all metal shavings from cut area.

2. Apply zinc-rich primer to thoroughly cover cut edge and/or drilled hole; let dry.

3. Apply (2) coats of custom finish paint matching fence color. Spray cans or paint pens by manufacturer shall be used to prime and finish exposed surfaces; it is recommended that paint pens be used to prevent overspray. Use of parts or components from another manufacturer will negate the manufacturer's warranty. Failure to complete this process may require the contractor to replace the complete fence panel(s).

3.5 CLEANING

A. The contractor shall clean the jobsite of excess materials. Metal fence installations shall be cleaned to remove scuff marks and dirt prior to Acceptance.

END OF SECTION

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Not Used

SECTION 32 84 00 - IRRIGATION SYSTEM

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Attention is directed to the printed form of the Contract of the City of Worcester and Division 1 of which these specifications are hereby made a part.

B. Include GENERAL CONDITIONS and applicable parts of Division 1 as part of this Section.

C. Coordinate work of this Section with other underground utilities and with trades responsible for their installation. Refer to respective Drawings pertaining to other work.

1.2 SECTION INCLUDES

A. Work to be done includes furnishing all labor, materials, equipment and services required to complete all irrigation work indicated on the Drawings, as specified herein, or both.

B. The mechanical point of connection for the irrigation system shall be a new 2-inch tap of the domestic water supply provided and installed by others.

C. The electrical point of connection for the irrigation system shall be to a 120-volt, 20-amp building electrical circuit provided and installed by others.

D. The Drawings and Specifications must be interpreted and are intended to complement each other. The Contractor shall furnish and install all parts, which may be required by the Drawings and omitted by the Specifications, or vice versa, just as though required by both. Should there appear to be discrepancies or question of intent, the Contractor shall refer the matter to the Owner’s Representative for decision, and his interpretation shall be final, conclusive and binding.

E. All necessary changes to the Drawings to avoid any obstacles shall be made by the Contractor with the approval of the Owner’s Representative.

F. Trench excavation, back filling and bedding materials, together with the testing of the completed installation shall be included in this work.

G. The work shall be constructed and finished in every respect in a good, workmanlike and substantial manner, to the full intent and meaning of the Drawings and Specifications. All parts necessary for the proper and complete execution of the work, whether the same may have been specifically mentioned or not, or indicated on the Drawings, shall be done or furnished in a manner corresponding with the rest of the work as if the same were specifically herein described.

H. Record Drawing as well as Operating & Maintenance Manual generation, in accordance to these specifications shall also be included in this work.

1.3 SCOPE

A. THE DESIGN OF THE SPRINKLER LAYOUT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR. The system shall be able to produce an application equal to 1/2 inch of water twice per week over the area to be irrigated (a total application equal to one inch per week). Each 1/2 inch application shall be applied over a period of six hours.

Shop drawings of the irrigation system layout shall show exact location of all fittings, equipment items, pipe sizes and controller location.

The irrigation system shall represent a single controller with water supplied from the City's existing water lines in the street. The system is designed for 21 gallons per minute. Minimum 65-psi dynamic pressure at full system flow is required downstream of the backflow preventer.

1.4 RELATED WORK

A. Carefully examine all of the Contract Documents for requirements that affect the Work of this Section.

1. Section 22 10 00 - Plumbing
2. Section 26 00 00 - Electrical
3. Section 31 00 00 - Earthwork
4. Section 32 90 00 - Lawns and Planting
5. Section 33 10 00 – Water Utilities

1.5 ORDINANCES, PERMITS AND FEES

A. The Work under this Section shall comply with all ordinances and regulations of authorities having jurisdiction.

B. The Contractor shall obtain and pay for any and all permits, tests and certifications required for the execution of Work under this Section.

C. Furnish copies of Permits, Certifications and Approval Notices to the Owner's Representative prior to requesting payment.

D. The Contractor shall include in their bid any charges by the Water Department, Utility Company, or other authorities for work done by them and charged to the Contractor.

1.6 EXAMINATION OF CONDITIONS

A. The Contractor shall fully inform himself of existing conditions on the site before submitting his bid, and shall be fully responsible for carrying out all 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, except those conditions described in the GENERAL CONDITIONS.

1.7 QUALITY ASSURANCE

A. Installer: A firm which has at least five (5) years of experience in work of the type and size required by this Section and which is acceptable to the Owner's Representative.

B. References: The Contractor must supply three references for work of this type and size with their bid including names and phone numbers of contact person(s).

C. Applicable requirements of accepted Standards and Codes shall apply to the Work of this Section and shall be so labeled or listed:

1. American Society for Testing & Materials (ASTM)

a. ASTM: A536 Ductile Iron Castings

b. ASTM: D1784 Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
c. ASTM: D1785 Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and Cl200.
d. ASTM: D2464 Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
e. ASTM: D2466 Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
f. ASTM: D2564 Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
g. ASTM: F477 Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
h. ASTM: D2737-99 Polyethylene (PE) Pressure rated tube.

2. National Plumbing Code (NPC)
3. National Electric Code (NEC)
4. National Sanitary Foundation (NSF)
5. American Society of Agricultural Engineers (ASAE)
6. Underwriters Laboratories, Inc. (UL)
7. Occupational Safety and Health Regulations (OSHA)

1.8 TESTS

A. Observation: The Owner’s Representative will be on site at various times to ensure the system is being installed according to the Specifications and Drawings.

B. Coverage Test: After completion of the system, test the operation of entire system and adjust sprinklers as directed by the Owner's Representative. Demonstrate to the Owner's Representative that all irrigated areas are being adequately covered. Furnish and install materials required to correct inadequacies of coverage due to deviations from the Drawings or where the system has been willfully installed when it is obviously inadequate or inappropriate without bringing it to the attention of the Owner. (See Part 3 - Execution).

C. The Owner’s Representative shall be notified 48 hours in advance for observations.

D. During final observation, the contractor shall be responsible for having two-way communication and sufficient personnel to provide instantaneous communication between the observation area and the controller for the system.

E. The Contractor shall provide copies of product specification sheets on all proposed equipment to be installed to the Owner's Representative for approval prior to the start of work, in accordance with the parameters of Division 1. Work on the irrigation system may not commence until product sheets are submitted and approved. Submittals shall be marked up to show proper nozzles, sizes, flows, etc.

1.9 SHOP DRAWINGS

A. Shop Drawings:

1. Layout of a 4 or 5-zone system for the rectangular area shown on plans with appropriate equipment schedules for optimal coverage.
2. Sprinkler Heads
3. Valves: Manual and Automatic
4. Master Valve
5. Exterior Controller, Enclosure and Post Mounting
6. Flow Sensor
7. Decoders
8. Valve Boxes
9. Pipe and Fittings
10. Wire and Connectors
11. Quick Coupling Valves

12. Rain Sensor
13. Moisture Sensor
14. Backflow Prevention Device/ Enclosure
15. Grounding Equipment
16. Miscellaneous Materials

B. Project Record Documents:

1. The Contractor shall provide and keep up-to-date a complete Record Set of Drawings of the system as the project proceeds. Drawings shall be updated daily, showing every change from the original Drawings and Specifications. Record Drawings shall specify and exactly locate sprinkler type; pop up height and nozzle for each sprinkler installed. Each valve box location to be referenced by distance from a minimum of two permanent locations. Controller(s), rain sensor(s), quick coupling valves, water meters, back flow prevention device and all other equipment shall be indicated on the drawings. All wire routing, wire size and splices shall be indicated. Main line pipe and wire route shall have two (2) distinctly different graphic symbols (line types). Prints for this purpose may be obtained from Owner's Representative at cost. This record set of drawings shall be kept at job site and shall be used only as a record set.

2. This set of documents shall also serve as work progress sheets and shall be the basis for measurement and payment for work completed. This record set of drawings shall be available at all times for observation and shall be kept in a location designated by Owner's Representative. Should this record set of drawings not be available for review or not be up-to-date at the time of the observation, it will be assumed no work has been completed. Provide copies of the redlined record set of drawings for Owner's Representative review on a monthly basis.

3. Make neat and legible notations on this record set of drawings daily as the work proceeds, showing the work as actually installed. For example, should a piece of equipment be installed in a location that does not match the plan, indicate that equipment in a graphic manner in the location of installation and so as to match the original symbols as indicated in the irrigation legend. Should the equipment be different from that specified, indicate with a new graphic symbol both on the drawings and the irrigation legend. The relocated equipment dimensions and northing and easting coordinates should then be transferred to the appropriate drawing in this record set of drawings at the proper time.

4. On or before the date of final field observation, deliver corrected and completed AutoCAD computer plots of "record drawings" on vellum and AutoCAD electronic files on disk to Owner's Representative as part of contract closeout. Delivery of plots will not relieve Contractor of the responsibility of furnishing required information that may have been omitted from the prints.

C. At the end of each segment of the project the contractor shall submit the following to the Owner's Representative.

1. Plumbing permits.
2. Material approvals.
3. Pressure line tests: By whom approved and date.
4. Materials furnished: Recipient and date.

1.10 DELIVERY, STORAGE AND HANDLING

A. Store and handle all materials in compliance with manufacturer instructions and recommendations. Protect from all possible damage. Minimize on-site storage.

1.11 GUARANTEE

A. The Contractor shall obtain in the Owner's name the standard written manufacturer's guarantee of all materials furnished under this Section where such guarantees are offered in the manufacturer's published product data. All these guarantees shall be in addition to, and not in lieu of, other liabilities that the Contractor may have by law.

B. In addition to the manufacturers guarantees the Contractor shall warrant the entire irrigation system, both parts and labor for a period of one (1) year from the date of acceptance by the Owner.

C. As part of the one-year warranty the Contractor shall perform the first year-end winterization and spring start-up for the irrigation system.

D. Should any problems develop within the warranty period because of inferior or faulty materials or workmanship, they shall be corrected to the satisfaction of the Owner’s Representative at no additional expense to the Owner.

E. A written warranty showing date of completion and period of warranty shall be supplied upon completion of each segment of the project.

1.12 COORDINATION

A. The Contractor shall at all times coordinate his work closely with the Owner’s Representative to avoid misunderstandings and to efficiently bring the project to completion. The Owner’s Representative shall be notified as to the start of work, progression and completion, as well as any changes to the drawings before the change is made. The Contractor shall also coordinate his work with that of his sub-contractors.

B. The Contractor shall be held responsible for and shall pay for all damage to other work caused by his work, workmen or sub-contractors. Repairing of such damage shall be done by the Contractor who installed the work, as directed by the Owner’s Representative.

1.13 MAINTENANCE AND OPERATING INSTRUCTIONS

A. Contractor shall include in their Bid an allowance for four (4) hours of instruction of Owner and/or Owner's personnel upon completion of check/test/start-up/adjust operations by a competent operator (The Owner’s Representative office shall be notified at least one (1) week in advance of check/test/start-up/adjust operations).

B. Upon completion of work and prior to application for acceptance and final payment, a minimum of three (3) three ring, hard cover binders titled MAINTENANCE AND OPERATING INSTRUCTIONS FOR THE FARLOW PARK POND IRRIGATION SYSTEM, shall be submitted to the Owner’s Representative office. After review and approval, the copies will be forwarded to the Owner. Included in the Maintenance and Operating binders shall be:

1. Table of Contents
2. Written description of Irrigation System.
3. System drawings:

    a. One (1) copy of the Record Drawing;
    b. One (1) reproducible of the Record Drawing;
    c. One (1) copy of the controller valve system wiring diagram

4. Listing of Manufacturers.

5. Manufacturers' data where multiple model, type and size listings are included; clearly and conspicuously indicating those that are pertinent to this installation.

    a. "APPROVED" submittals of all irrigation equipment;
    b. Operation:
    c. Maintenance: including complete troubleshooting charts.
    d. Parts list.
    e. Names, addresses and telephone numbers of recommended repair and service companies. A copy of the suggested "System Operating Schedule" which shall call out the controller program required (zone run time in minutes per day and days per week) in order to provide the desired amount of water to each area under "no-rain" conditions.

6. Winterization and spring start-up procedures.
7. Guarantee data.

1.14 PROCEDURE

A. Notify all city departments and/or public utility owners concerned, of the time and location of any work that may affect them. Cooperate and coordinate with them in the protection and/or repairs of any utilities.

B. Provide and install temporary support, adequate protection and maintenance of all structures, drains, sewers, and other obstructions encountered. Where grade or alignment is obstructed, the obstruction shall be permanently supported, relocated, removed or reconstructed as directed by the Owner's Representative.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials to be incorporated in this system shall be new and without flaws or defects and of quality and performance as specified and meeting the requirements of the system. All material overages at the completion of the installation are the property of the Contractor and shall be removed from the site.

B. No material substitutions from the irrigation products described in these specifications and shown on the drawings shall be made without prior approval and acceptance from the Owner's Representative.

2.2 PVC IRRIGATION PIPE

A. All pipe shall bear the following markings: Manufacturer's name, nominal pipe size, schedule or class, pressure rating in psi, and date of extrusion.

B. All lateral pipe shall be PVC, Class 200, Type 1120, SDR 21, Solvent-Weld PVC, conforming to ASTM No. D2241 as manufactured by Certainteed, Cresline, JM or approved equal.

C. All mainline pipe shall be PVC, Class 200, Type 1120, SDR 21, Gasket-Joint PVC, conforming to ASTM No. D2241 as manufactured by Certainteed, Cresline, JM or approved equal.

D. The pipe insertion mark shall be visible to show the proper depth into spigot.

2.3 PVC PIPE SLEEVES

A. All pipe sleeves beneath non-soil areas shall be PVC, Class 160 water pipe as manufactured by Certainteed, Cresline, JM or equal. Minimum sleeve size to be 3-inch.

2.4 WIRE CONDUIT

A. Conduit for wiring beneath non-soil areas shall be PVC, SCH-40 conduit with solvent-weld joints, as manufactured by Certainteed, Cresline, JM or approved equal.

B. Sweep ells shall be standard electrical type PVC schedule 40 long sweep elbows. Cap sweep ell with tri-plug with the ring for securing nylon pull rope.

C. Conduit for above ground wiring to rain sensors or controllers shall be galvanized, rigid metallic conduit.

2.5 PVC IRRIGATION FITTINGS

A. Fittings for solvent weld PVC pipe, 2-1/2 inch and smaller in size, shall be Schedule 40 solvent weld PVC fittings as manufactured by Dura, Lasco, Spears or approved equal.

B. Fittings shall bear manufacturer’s name or trademark, material designation, size, and applicable I.P.S. schedule.

C. All PVC threaded connections in and out of valves shall be made using Schedule 80 toe nipples and Schedule 40 couplers or socket fittings. Schedule 40 threads will not be approved for installation.

D. PVC solvent shall be NSF approved, for Type I and Type II PVC pipe, and Schedule 40 and 80 fittings. Cement is to meet ASTM D2564 and FF493 for potable waterpipes. PVC solvent cement shall be Rectorseal Gold, IPS Weld-ON 711, Oatey Heavy Duty Cement or approved equal, and shall be used in conjunction with the appropriate primer. Primer shall be NSF approved, and formulated for PVC and CPVC pipe applications. Primer is to meet ASTM F 656. Primer shall be Rectorseal Jim PR-2, IPS Weld-ON P-68 Clear, Oatey Clear Primer for PVC and CPVC, or approved equal.

E. Fittings for PVC main line pipe, for all directional changes, pipe reductions and plugs 3- inch and larger in size shall be deep bell push-on gasket joint ductile iron fittings for PVC pipe. Fittings shall be manufactured of ductile iron, grade 70-55-05 in accord with ASTM A536 and gaskets shall meet ASTM F477. Fittings shall be as manufactured by Harrington Corporation, Harco, or approved equal. For main line pipe to zone valve / lateral pipe connections, Harco or approved equal push-on gasket joint ductile iron service tees shall be used. Saddles, (strap, bolt down or snap) will not be approved for installation.

F. All nipples to be schedule 80 PVC.

2.6 POLYETHYLENE IRRIGATION PIPE

A. Piping 1-1/2 inch and smaller in size as indicated on the drawings may also be installed with polyethylene (PE3408) pipe, SDR 15, Class 100, Type III, Grade 3, Class C conforming to ASTM D2239, with a minimum pressure rating of 100 psi as manufactured by Oil Creek or approved equal. Polyethylene pipe shall only be used in landscape areas.

2.7 POLYETHYLENE IRRIGATION FITTINGS

A. Fittings for polyethylene pipe shall be insert PVC or Nylon type fittings. Fittings shall conform to NSF standards and be attached with two (2) dog-eared stainless steel clamps. Clamps shall be as manufactured by Oetiker or approved equal.

B. Supply only pipes and fittings that are marked by the manufacturer with the appropriate ASTM designations and pressure ratings and are free from cracks, wrinkles, blisters, dents or other damage. Fittings shall be per ASTM D2609 as manufactured by Dura, Lasco or approved equal.

2.8 SPRAY SPRINKLERS

A. Full and part circle pop up spray sprinklers shall be pressure regulating, plastic construction with ratcheting riser, removable nozzle and check valve. Nozzle size shall be as indicated on the drawing and in the legend. Pop-up height shall be 4 inches for turf.

B. Sprinkler shall carry a minimum 3-year exchange warranty against defects. Sprinklers shall be manufactured by Rain Bird, Hunter Industries, or approved equal.

2.9 LARGE ROTARY SPRINKLERS

A. Large rotary sprinklers shall be gear-driven, rotary type with drain check valve and stainless steel riser designed for in-ground installation. The nozzle assembly shall elevate three inches when in operation and retraction shall be achieved by a stainless steel spring. Check valve shall be capable of holding up to 10 feet of elevation. Sprinkler shall be capable of covering a 49-61 foot radius and flow range of 7.5 to 15.7 gpm at 60 pounds per square inch of pressure.

B. All sprinkler parts shall be removable through the top of the unit by removing a heavy-duty threaded cap. The sprinkler shall have a one- inch (1") IPS water connection on the bottom of the sprinkler.

C. Sprinklers shall be model I25-ADS/36S by Hunter Industries, model 7005-SS by Rain Bird, equivalent Toro fixture or approved equal.

2.10 ELECTRIC CONTROL VALVES

A. Electric control valves shall be one, one and one half and two-inch remote control, diaphragm type, fiberglass or reinforced nylon body plastic valves with manual flow control, manual bleed screw and 200 psi pressure rating.

B. Valves shall be manufactured by Rain Bird model PEB, Hunter Industries model ICV or approved equal.

2.11 MASTER VALVE

A. Electric control valves shall be three inch remote control, diaphragm type, brass valve with manual flow control, manual toggle switch with internal porting, 200 psi pressure rating and 24 volt activation. Valve shall be equipped with a self-flushing filter, self cleaning metering rod, stainless steel solenoid seat and operate with a slow closure speed.

B. Valves shall be manufactured by Weathermatic 1 ½-21000 series or approved equal.

2.12 VALVE BOXES

A. All valve boxes shall be manufactured from unformed resin with a tensile strength of 3,100-5,500 psi conforming to ASTM D638. All boxes shall be green in color. Covers shall be green in color unless otherwise specified.

B. Valve boxes for single electric valves, isolation valves, and quick coupling valves shall be 10-inch round valve boxes with metal detection and bolt down covers

C. Valve boxes for dual electric valves and master valve shall be 12-inch standard valve boxes with metal detection and bolt down covers.

D. Valve boxes for wire splices shall be 10 inch round valve boxes with detectable disks as manufactured by Armor, Part 181104 or 181112. All splices shall be in separate valve boxes and not included with isolation valves.

E. Valve box extensions shall be provided and installed as required for proper box depth. Valve box extensions shall be made by the same manufacturer.

F. Valve boxes shall be manufactured by Armor or approved equal.

2.13 AUTOMATIC CONTROLLER

A. Controller shall be Pro-C Model #PC400 as manufactured by Hunter Industries or approved equal.

2.14 DECODERS

A. Decoders and sensor decoders shall be as manufactured by Hunter Industries model ICD decoders and ICD-SEN or approved equal.

2.15 QUICK COUPLING VALVES

A. The valve body shall be of cast brass construction with a working pressure of 125 psi. The valve seat disc plunger body shall be spring loaded so that the valve is normally closed under all conditions when the key is not inserted.

B. The top of the valve body receiving the key shall be equipped with a single slot and smooth face to allow the key to open and close the valve slowly with a one-half turn. The quick coupling valve shall be equipped with a vinyl cover.

C. The valve body construction shall be such that the coupler seal washer may be removed from the top for cleaning or replacement without disassembling any other parts of the valve.

D. Keys shall be single lug with 1-inch male thread and 3/4-inch female thread at the top.

E. Contractor shall provide two (2) keys for quick couplers and two (2) 1-inch x 1-inch swivel hose ells.

F. Quick coupling valves, keys and swivels shall be manufactured by Rain Bird models 5RC, 55K-1 and SH-2, Hunter Industries, model QCV-100, QCV-100K and HS-100 or approved equal.

2.16 WIRE

A. All valve control wire shall be #14-2 AWG, two wire, twisted copper pair, UL- approved direct burial AWG-U.F. 600V and shall meet all state and local codes for this service.

B. In ground wire connections shall be UL listed, manufactured by 3M, model DBY-6 splice kits. All wire splices shall be made in valve boxes, at controller, or at valves.

C. Wire type and method of installation shall be in accordance with local codes for NEC Class II circuits of 30-volt A.C. or less.

D. Wire shall be as manufactured by Hunter Industries model IDWIRE1 in minimum 2,500 foot reels or approved equal.

2.17 ISOLATION VALVES

A. Isolation valves 2-1/2 inches and smaller in size shall be gate type, of bronze construction, US Manufacture, 200 WOG with steel cross handle and 200 psi rating. Gate valves to be as manufactured by Nibco, model T-113-K, or approved equal.

B. Isolation valves 3 inches and larger in size shall be cast iron epoxy coated inside and outside, long bell length ring-tite valves, 200 psi rated, ductile iron gland flange, bronze stem-seal box, o-ring stem seal replaceable under pressure, stainless steel stem, 2 inch operating nut and replaceable disc conforming to AWWA C-509 as manufactured by Nibco, Model P-619-RW or approved equal.

2.18 SWING JOINTS

A. Spray sprinklers, small rotary sprinklers and medium rotary sprinklers shall be installed on swing pipe assemblies, minimum length 6 inches, maximum 18 inches.

B. Large rotary sprinklers shall be installed on 1-inch prefabricated PVC unitized swing joint assemblies with double o-ring seals, minimum 315 psi rating and minimum length of 12 inches.

C. Quick coupling valves to be installed on 1-inch prefabricated PVC unitized swing joint assemblies with double o-ring seals, minimum 315 psi rating and minimum length of 12 inches with brass insert and stabilizer (unless stabilizer is an integral part of the quick coupling valve).

2.19 SENSORS

A. RAIN SENSOR shall be plastic in construction with adjustable interruption point, 1/2-inch IPS threads and stainless steel vandal resistant guard. Rain sensor shall be manufactured by Hunter Industries, model Rain-Clik or approved equal with sensor guard.

B. SOIL MOISTURE SENSOR shall consist of a moisture sensor probe and an electronic module. Sensor and module shall be ‘Soil-Clik’ and ‘Soil Clik Probe’ by Hunter Industries, or approved equal.

C. FLOW SENSOR automatically shuts down system if an overflow condition occurs due to a ruptured pipe. Sensor shall be ‘Flow-Clik’ by Hunter Industries, or approved equal.

2.20 CRUSHED STONE

A. Crushed stone shall be as specified in SECTION: EARTHWORK. Crushed stone shall be used under valve boxes.

2.21 SAND

A. Sand used for backfilling of trenches; under, around and over PVC lines shall be as specified in Section 31 00 00: EARTHWORK.

2.22 CONCRETE BASES AND THRUST BLOCKS

A. Standard concrete mix shall be in accordance with ASTM C150, ASTM C-33, and ASTM C-94 with a compressive strength (28 days) of 3,000 psi.

B. All bell and gasket mainline pipe and fittings shall have thrust blocks sized and placed in accordance with pipe manufacturer's recommendations for standard concrete mix. Thrust blocks shall be installed at all tees, elbows, crosses, reducers, plugs, caps and valves. Contractor shall be responsible to insure the stability of all thrust blocks.

C. All concrete bases shall be standard concrete mix. Sizes shall be as indicated on the Drawings and sited in the Specifications.

2.23 SPARE PARTS

A. Contractor shall supply the following tools and equipment to the Owner's Representative before final observation:

1. Two (2) wrenches for disassembling and adjusting each type of sprinkler head provided.
2. One (1) quick coupler key assembly for every five or fraction thereof of each type of quick coupling valve provided.
3. One (1) of each type of gate valve used in the project.
4. Two (2) of each type sprinkler head and pattern (PC & FC) used in the project.
5. Two (2) of each type nozzle used in the project.

B. Before final observation can occur, written evidence that the Owner's Representative has received the tools and equipment must be shown to the Owner.

PART 3 - EXECUTION

3.1 GENERAL

A. Before work is commenced, hold a conference with the Owner's Representative to discuss general details of the work.

B. Examine all contract documents applying to this Section noting any discrepancies and bringing the same to the attention of the Owner's Representative for timely resolution.

C. All work indicated on Drawings shall be provided whether or not specifically mentioned in the Specifications.

D. If there are ambiguities between Drawings and Specifications, and specific interpretation or clarification is not issued prior to bidding, the interpretation or clarification will be made only by Owner's Representative and Contractor shall comply with the decisions. In the event the installation contradicts the directions given, the installation shall be corrected by Contractor at no additional cost to Owner.

E. Verify dimensions and grades at job site before work is commenced. Do not proceed with installation of the landscape irrigation system when it is apparent that obstructions or grade differences exist or if conflicts in construction details. Legend or specific notes are discovered. All such obstructions, conflicts, or discrepancies shall be brought to the attention of the Owner's Representative.

F. Make all field measurements necessary for the work noting the relationship of the irrigation work to the other trades. Coordinate with other trades (landscaping and other site work trades). Project shall be laid out essentially as indicated on the Drawings, making minor adjustments for variations in the planting arrangement. Major changes shall be reviewed with the Owner's Representative prior to proceeding.

G. Layout of sprinkler lines indicated on the Shop Drawing is diagrammatic only. Location of sprinkler equipment is contingent upon and subject to integration with all other underground utilities. Contractor shall employ all data contained in the Contract Documents and shall verify this information at the construction site to confirm the manner by which it relates to the installation.

H. Coordinate installation of all sprinkler materials, including pipe, to avoid conflict with the trees, shrubs, or other plantings.

I. During progress of work, a competent superintendent and all assistants necessary shall be on site. All shall be satisfactory to the Owner's Representative. The superintendent shall not be changed, except with the consent of the Owner's Representative, unless that person proves unsatisfactory and ceases to be employed. The superintendent shall represent the Contractor in his absence and all directions given to the superintendent shall be as binding as if given to the Contractor.

J. At all times, protect landscaping, existing trees, paving, structures, walls, footings, etc. from damage. Any inadvertent damage to the work of another trade shall be reported at once.

K. Replace, or repair to the satisfaction of the Owner, all existing paving disturbed during course of work. New paving shall be the same type, strength, texture, finish, and be equal in every way to removed paving.

3.2 PIPE AND FITTINGS INSTALLATION

A. Using proper width trencher chain, excavate a straight (vertical) and true trench to a depth of 2-inch of pipe invert elevation.

B. Loam or topsoil encountered within the limits of trench excavation for irrigation mains and branch lines shall be carefully removed to the lines and depths as shown on the Drawings and stockpiled for subsequent replacement in the upper 6 inches of the trench from which it is excavated. Such removal and replacement of the quantities of loam shall be considered incidental to the irrigation system and no additional compensation will be allowed therefore.

C. Pipe shall be laid on undisturbed trench bottom provided suitable base is available - no rock larger than 1-inch or sharp edges; if not, excavate to 2-inch below pipe invert and provide and install sand base or crushed stone upon which to lay pipe.

D. Back filling shall be accomplished as follows: the first 10-inch of backfill material shall contain no foreign matter and no rock larger than 1-inch in diameter. Carefully place material around pipe and wire and tamp in place. Remainder of backfill shall be laid-up in 6-inch (maximum) lifts and tamped to compaction with mechanical equipment. Compact backfill in trenches to dry density equal to the adjacent undisturbed soil, and conform to adjacent grades without dips, sunken area, humps, or other irregularities. Frozen material shall not be used for backfill.

E. Do backfilling when pipe is cool. During hot weather cool pipe by operating the system for a short period, or by backfilling in the early part of the morning before the heat of the day.

F. Do not, under any circumstances, use truck wheels for compacting soil.

G. Where feasible, Owner's Representative may authorize the use of flooding in lieu of tamping.

H. Restore grades and repair damage where settling occurs.

I. Clean bell and spigot ends and make all gasketed joints in strict accordance with manufacturer's recommendations, making certain not to apply an excess of lubricant, and wiping off any excess lubricant from each connection. Maximum deflection per joint shall not exceed manufacturer's recommendations.

J. Make all solvent-weld joints in strict accordance with manufacturer's recommendations, making certain not to apply an excess of primer or solvent, and wiping off excess solvent from each connection. Allow welded joints at least 15 minutes set-up/curing time before moving or handling. When the temperature is above 80º F, allow connections to set minimum 24 hours before pulling or pressure is applied to the system. When temperature is below 80º F, follow manufacturer's recommendations. Provide and install for expansion and contraction as recommended. Wire shall be laid in same trench as mainline and at pipe invert (see Wire Installation).

K. Mainline pipe shall have minimum 22 inches of COVER (excavate to invert as required by pipe size). Lateral pipe shall have minimum 16 inches of COVER for PVC and 12 inches of cover for Polyethylene (excavate to invert as required by pipe size).

L. Cut plastic pipe with handsaw or pipe-cutting tool, removing all burrs at cut ends. All pipe cuts are to be square and true. Bevel cut end as required to conform to Manufacturer's Specifications.

M. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the trench. At times, when installation of the piping is not in progress, the open end(s) of the pipe shall be closed by a watertight plug or other means. All piping, which cannot temporarily be joined, shall be sealed to make as watertight as possible. This provision shall apply during the lunch hour as well as overnight. Pipe not to be installed that day shall not be laid out. Should water enter the trench during or after installation of the piping, no additional piping may be installed or back filled until all water is removed from the trench. Pipe shall not be installed when water is in the trench, when precipitation is occurring, or when the ambient temperature is at 40º F or below. Pipe installed at temperatures below 40º F shall be removed and replaced at no cost to the Owner. PVC pipe shall be snaked in the trench to accommodate for expansion and contraction due to changes in temperature.

N. In installing irrigation pipe the Contractor shall route the pipe as necessary to prevent damage to tree roots. Where trenching must occur near trees, the Contractor shall provide proper root pruning and sealing methods to all roots 1-inch and larger.

O. Maintain 6-inch minimum clearance between sprinkler lines and lines of other trades. Do not install sprinkler lines directly above another line of any kind.

P. Maintain 1-inch minimum between lines which cross at angles of 45 to 90 degrees.

Q. Exercise care when excavating, trenching and working near existing utilities.

R. Throughout the guarantee period it will be the responsibility of the Contractor to refill any trenches that have settled due to incomplete compaction.

S. Pulling of pipe will be allowed provided soil is suitable and specified depth of bury can be maintained.

3.3 THRUST BLOCKING

A. All ringtite bell-end fittings shall be blocked with an adequately sized thrust block as per ASAE Standard S376.1 and as depicted in the details. Blocking shall be in accordance with pipe and fitting manufacturer's recommendations. Thrust blocks shall be required at all changes in size and direction of bends, reducers, plugs and tees. Thrust blocks shall be installed against undisturbed soil in all cases. Concrete thrust blocks shall utilize 3,000-psi standard concrete mixture. Bricks, stones, boulders, etc. will not be accepted as thrust blocks or thrust block material. Sackcrete will not be permitted as a thrust blocking material. Contractor to supply all material needed for thrust blocking.

B. Size of thrust block shall be determined by working pressure, size and type of fitting, and soil conditions. Calculate area required for concrete thrust block in contact with soil. Refer to fittings manufacturer’s thrust block sizing table to determine size of thrust block for each condition.

C. Ensure stability of thrust blocks.

D. Under no circumstances will concrete block be approved for thrust blocks including for 2-inch fittings.

3.4 ELECTRICAL WIRE CONDUIT INSTALLATION

A. Electrical conduit shall be installed in all non-soil areas, as well as for all above ground wiring where wire passes under or through walls, walks and paving to controllers and rain sensor.

B. Conduit shall extend 18 inches beyond edges of walls and pavement.

3.5 PIPE SLEEVING INSTALLATION

A. Sleeving shall be installed wherever piping is going under a non-soil area, generally where indicated on the Drawings. Minimum cover over all sleeving pipe shall be 24 inches as shown on the detail.

B. Sleeving shall extend 18 inches beyond edges of walls and pavement.

3.6 ISOLATION VALVE INSTALLATION

A. Install isolation valves per detail where indicated on the Drawings. Install all isolation valves on a level crushed stone base so that they can be easily opened or closed with the appropriate valve wrench. Install specified valve box over each isolation valve.

B. Check and tighten valve bonnet packing before valve box and backfill installation.

C. Provide and install thrust blocks for ring-tite valves as per detail.

3.7 VALVE BOX INSTALLATION

A. Furnish and install a valve access box for each electric valve, quick coupling valve, isolation valve, decoder and wire splice.

B. All valve access boxes shall be installed on a minimum 4-inch crushed stone base. Finish elevation of all boxes shall be at grade. All crushed stone to be supplied by the Contractor and

installed before valve box. Crushed stone shall not be poured into previously installed valve boxes.

3.8 24 VOLT CONTROL AND MASTER VALVE INSTALLATION

A. Control valves shall be installed on a level crushed stone base. Grade of bases shall be consistent throughout the project so that finish grades fall within the limits of work. Valves shall be set plumb with adjusting handle and all bolts, screws and wiring accessible through the valve box opening. Valves shall be set in a plumb position with 24-inch minimum maintenance clearance from other equipment.

B. Install at sufficient depth to provide not more than 6-inch, nor less than 4-inch cover from top of valve to finish grade.

C. Adjust zone valve operation after installation using flow control device on valve.

D. Master valve shall be placed in a standard valve box.

3.9 WIRING INSTALLATION

A. Wiring shall be installed along with the main line. Multiple wire bundles shall be cinched together at maximum 12-foot centers using plastic cable cinches and shall be laid beside, and at the same invert as, the irrigation lines. Sufficient slack for expansion and contraction shall be maintained and wiring shall at no point be installed tightly. Provide and install an additional 8 inches to 12 inches slack at all changes of direction. Wiring in valve boxes shall be a sufficient length to allow the valve solenoid, splice, and all connections to be brought above grade for servicing. This additional slack shall be coiled for neatness in the valve box. Each valve shall have a separate wire back to the controller.

B. All wire shall be laid in trenches and shall be carefully back-filled to avoid any damage to the wire insulation or wire conductors themselves. In areas of unsuitable material, the trench shall have a 2 inches layer of sand or stone dust on the bottom before the wires are laid into the trench and back-filled. The wires shall have a minimum of 12 inches of cover. Wire not to be installed that day shall not be laid out.

C. An expansion curl shall be provided and installed within 6 inches of each wire connection to a solenoid and at least every 100 feet of wire length on runs more than 100 feet in length. Expansion curls can be formed by wrapping five (5) turns of wire around a 1-inch diameter or larger pipe and then withdrawing the pipe.

D. Provide and install a two wire path to all 24 volt valves and sensors within the project. Maximum distance of any two wire path shall not exceed 10,000 ft.

E. Service wiring in connection with Drawings and local codes for 24-volt service. All in-ground wire connections shall be waterproofed with 3M DBY-6 splice kits. All splices shall be made in valve boxes (wire runs requiring splices between valve locations shall be provided and installed in splice box-valve box shall be used). Splice locations shall be shown on the Record Drawings.

F. Contractor shall provide a complete wiring diagram showing wire routing for the connections between the controller and valves. See section one for the inclusion of wiring diagram in operation and maintenance manuals.

3.10 CONTROLLER INSTALLATION

A. Contractor to install controller in new enclosure in location as shown on the drawings. Contractor to wire valves, master valve, flow sensor and rain sensor into controller and set proper program.

B. Wire controller to 120-volt electrical supply provided and installed to the controller locations by others.

C. Keys shall be turned over to Owner's Representative.

3.11 GROUNDING INSTALLATION

A. Each grounding rod shall be driven into the ground its full length within 8-feet of the controller and connected via a Cadweld connection to #6 solid, bare copper wire. The copper wire is to be installed in as straight a line as possible, and if it is necessary to make a turn or bend, it shall be done in a sweeping curve with a minimum radius of 8 inches and a minimum included angle of 90 degrees. There shall be no splices in the bare copper wire. The top of the ground rod shall be driven below the ground surface. A 4-inch grated cover as specified, set a minimum of 1-inch below grade, shall be placed over the ground rod and Cadweld connection for periodic maintenance. Cover shall be installed on a minimum of 6 inches of 4-inch ADS corrugated polyethylene, perforated drainage pipe. Plates shall be installed 36 inches below grade with 50 lbs of Power Set ground enhancement material spread evenly below the plate and 50 lbs of Power Set ground enhancement material spread evenly above the plate in accordance with the manufacturer's requirements. Plates shall also be covered with a 4 inch grated cover as specified, set a minimum of 1-inch below grade, to facilitate drainage onto the plate. Cover shall be installed on a minimum of 36 inches of 4-inch ADS corrugated polyethylene, perforated drainage pipe.

B. Multiple controller locations shall have separate grounding for each controller. Grounding rods shall be separated a minimum of 20 feet between grids. Grids shall be installed in an irrigated area.

C. When tested, grounding grid shall have an earth resistance no greater than 5 ohms. If earth resistance is greater than 5 ohms, additional grounding plates and enhancement material shall be added to system until desired test results have been meet.

3.12 RAIN SENSOR INSTALLATION

A. Install rain sensor generally where indicated on the drawings. Coordinate final location of rain sensor with Owner's Representative. Rain sensor shall be in direct contact with the weather and not in contact with the irrigation spray.

B. Install rain sensor wiring within 1/2-inch conduit where exposed. All above ground wires shall be installed in conduits.

C. Wire rain sensor directly to controller.

3.13 FLOW SENSOR

A. Wire sensor directly to controller.

3.14 SPRINKLER INSTALLATION

A. Spray sprinklers, small rotary sprinklers and medium rotary sprinklers shall be installed flush (perpendicular) to grade on swing pipe assemblies, minimum length 6 inches, maximum 18 inches.

B. Large rotary sprinklers shall be installed flush to grade on 1-inch prefabricated PVC unitized swing joint assemblies with integral o-rings, minimum length 12 inches.

C. Sprinklers shall not exceed maximum spacing indicated on Drawings.
D. Adjust sprinkler zone after installation using flow control device on valve.

3.15 QUICK COUPLING VALVE INSTALLATION

A. Provide and install quick coupling valves where indicated on the Drawings.

B. Quick coupling valves to be mounted on 1-inch prefabricated PVC unitized swing joint assemblies with integral o-rings, minimum length 12 inches with brass insert and stabilizer as per details.

3.16 BACKFLOW PREVENTION INSTALLATION

A. Install 2-inch reduced pressure back flow prevention assembly in above grade enclosure as specified. Back flow installation shall be in accordance with Newton Water Dept.

3.17 CHECK/TEST/START-UP/ADJUST

A. Flushing:

1. After all piping, valves, sprinkler bodies, pipe lines and risers are in place and connected, but prior to installation of sprinkler internals, open the control valves and flush out the system under a full head of water.
2. Sprinkler internals, flush caps and riser nozzles shall be installed only after flushing of the system has been accomplished to the full satisfaction of the Owner’s Representative.
3. Contractor shall be responsible for flushing the entire system after installation is complete and will be responsible for any clogged nozzles for thirty (30) days after substantial completion of this portion of the landscape irrigation system.

B. Testing:

1. Leakage test: test all lines for leaks under operating pressure. Repair all leaks and re-test.
2. Coverage test: perform a coverage test in the presence of the Owner's Representative (notify Architect at least seven (7) days in advance of scheduled coverage test). Representative will determine if the water coverage is complete and adequate. Readjust heads and/or head locations as necessary or directed to achieve proper coverage.
3. All testing shall be at the expense of the Contractor.

3.18 CLEANING AND ADJUSTING

A. At the completion of the work, all parts of the installation shall be thoroughly cleaned. All equipment, pipe, valves and fittings shall be cleaned of grease, metal cuttings and sludge which may have accumulated by the operation of the system for testing.

B. Adjust sprinkler heads, valve boxes, and quick coupling valves to grade as required, so that they will not be damaged by mowing operations.

C. Continue sprinkler coverage adjustment as required by settlement, etc., throughout the guarantee period.

D. Each control zone shall be operated for a minimum of 5 minutes and all heads checked for consistency of delivering water. Adjustments shall be made to sprinklers that are not consistent to the point that they match the manufacturer's standards. All sprinklers, valves, timing devices

or other mechanical or electrical components, which fail to meet these standards, shall be rejected, replaced and tested until they meet the manufacturer's standards.

3.19 ACCEPTANCE AND OPERATION BY OWNER

A. Upon completion of the work and acceptance by the Owner, the Contractor shall be responsible for the training of the Owner's Representative(s) in the operation of the system (provide minimum 48 hours written notice in advance of test). The Contractor shall furnish, in addition to the Record Drawings and operational manuals, copies of all available specification sheets and catalog sheets to the Owner's personnel responsible for the operation of the irrigation system. The Contractor shall guarantee all parts and labor for a minimum period of one (1) year from date of acceptance.

B. Conditions for acceptability of work for start of maintenance by Owner issued by Owner or Owner’s Representative shall include but not be limited to:

1. Punch list items complete and approved by Owner or Owner’s Representative.
2. Landscape irrigation system complete and in place.
3. Record drawings complete.
4. Maintain installation and watering schedules until all conditions noted above have been completed.

3.20 CLEAN UP

A. Upon completion of all installation work, Contractor shall remove all leftover materials and equipment from the site in a safe and legal manner.

B. Contractor shall remove all debris resulting from work of this section.

C. Contractor shall regrade, lightly compact, and replant around sprinkler heads where necessary to maintain proper vertical positioning in relation to established grade.

D. Contractor shall fill all depressions and eroded channels with sufficient soil mix to adjust grade to ensure proper drainage. Compact lightly, and replant filled areas in accord with Drawings requirements.

END OF SECTION

SECTION 32 90 00 - LAWNS AND PLANTING

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the printed form of the Contract of the City of Worcester and Division 1 of which these specifications are hereby made a part.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials, and equipment necessary to complete the work of this Section, including but not limited to the following:

B. Preparation of final subgrades in lawns and plant beds; testing, furnishing and spreading of topsoil and planting soil; fine grading; application of soil conditioners; edging and mulching new plant beds; erosion control; broadcasting and hydroseeding of seed mixes; planting of trees, shrubs, perennials and grasses; maintenance, and guarantee.

1.3 RELATED WORK

A. Section 01 23 00 - Alternates
B. Section 01 57 13 - Temporary Erosion and Sedimentation Controls
C. Section 31 00 00 - Earthwork
D. Section 32 84 00 - Irrigation System

1.4 REFERENCES

A. ASNS: "American Standard for Nursery Stock", American Association of Nurserymen, 1973 Edition.
B. ASTM: American Society for Testing and Materials.
C. Federal Specification JJJ-S-181b, Seeds, Agricultural.
D. Federal Specification O-F-241c(1), Fertilizers, Mixed, Commercial.
E. SPN: "Standardized Plant Names", American Joint Committee on Horticultural Nomenclature, 1942 Edition.
F. SRA-156: U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act.

1.5 CERTIFICATES, INSPECTIONS, TESTS AND SUBMITTALS

A. Provide a complete soil analysis for topsoil from all sources by a competent laboratory approved by Owner.

1. Perform analysis in accordance with ASTM D422. Include in the analysis tests for physical properties, grain size, hydrogen-ion value, organic matter content and available nitrogen, phosphoric acid, potash and iron. Also include tests for soluble salts, lead and other toxic elements or conditions which may be detrimental to plant growth.
2. Include recommendations for the kinds and quantities of soil amendments to be used in the report of the analysis Submit the report of the analysis to Owner at least 30 days prior to delivery of topsoil to the site or use in the work. The cost of laboratory tests shall be paid by the Contractor.

B. At least 30 days prior to intended use, the Contractor shall provide the following samples and submittals for approval in conformance with the requirements of General Conditions Section 007000, SUBMITTALS. Do not order materials until Owner's approval of samples, certifications

or test results has been obtained. Delivered materials shall closely match the approved samples. Acceptance shall not constitute final acceptance. The Owner reserves the right to reject on or after delivery any material that does not meet these Specifications.

1. Material Sampling and Testing of Loam Borrow from Off-Site Sources, and Organic Compost shall be specified, performed and paid for under this Section.

    a. No planting soil, loam borrow or compost from off-site sources shall be delivered until the review of samples and test results by the Owner, but such review shall not constitute final acceptance. The Owner reserves the right to reject on or after delivery any material which does not meet specifications or match the sample.

2. Fertilizer: Submit product literature of seeding and planting fertilizers and certificates showing composition and analysis.

3. Seed and Sod: 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.

4. Hydroseeding: Prior to the start of hydroseeding, submit a certified statement for approval as to the number of pounds of materials to be used per 100 gallons of water.

5. All Amendments required to amend a specific soil in order shall meet these specifications.

C. Plants shall be subject to inspection and approval by the Owner at their place of growth, and upon delivery for conformity to specification requirements. Such approval shall not obviate the right of inspection and rejection during the progress of the work.

1. Submit a written request to the Owner at least 10 calendar days prior to digging for inspection of plant materials at their place of growth. State in the written request the place of growth and quantity of plants to be inspected. The Owner reserves the right to refuse inspection at this time if, in his judgment, a sufficient quantity of plants are not available for inspection.

D. Comply with all applicable State and Federal laws in respect to inspection for plant diseases and infestation for all plants including seed. Provide certificates of inspection with the invoice for each shipment as may be required by laws for transportation. File certificates with Owner prior to acceptance of material. Inspection by State and Federal governments at place of growth does not preclude rejection of material at the site.

E. Submit samples of the following materials in the quantities indicated for approval prior to use.

1. Mulch for planting: .5 cubic foot.
2. Compost: .5 cubic foot.

1.6 DELIVERY, STORAGE AND HANDLING

A. Do not deliver TOPSOIL to the site until soil analysis has been approved by the Owner. Do not deliver topsoil to the site in a frozen or muddy condition.

B. Deliver all SOIL AMENDMENTS to the site in manufacturer's standard containers showing weight, analysis, name of manufacturer and warranty. Append a summary of this product information to each invoice. Store in a weatherproof storage place in such a manner that they

will be kept dry and their effectiveness not impaired. Caked or otherwise damaged soil amendments shall be rejected.

C. Deliver SEED in original sealed standard sized containers. Label all seed in accordance with State regulations and SRA-156. Store seed in such a manner that it will be protected from damage by heat, moisture, rodents or other causes. Seed which has become wet, moldy or otherwise damaged shall be rejected.

D. For Sodding, if rain is predicted, postpone sod delivery. Sod cannot be unrolled at wet sites. To cancel order, give supplier a minimum of 24 hours notice.

1. For delivery of Big Rolls, contractor shall have 4 people on site to assist with delivery.
2. Irrigation system or sprinklers/hoses shall be working the day of delivery and installation.

E. PLANT MATERIAL

1. Immediately before digging spray all plant material in full leaf with anti-transpirant, applying an adequate film over trunks, branches, twigs and foliage. Do not prune plants before delivery.

2. Dig, ball and burlap (B&B) plants with firm natural balls of earth of diameter not less than that recommended by ASNS, and of sufficient depth to include the fibrous and feeding roots. Dig balls for collected material at least 1/3 greater in diameter than above. Double burlap all plants which are 6 inches in caliper and larger.

3. Dig up and prepare plants for shipment in a manner that will not cause damage to branches, shape and future development of the plants after replanting. Cover all plant material while in transit.

4. Do not remove container grown material from containers until ready for planting.

5. Protect plants at all times from sun or drying winds. Keep plants that cannot be planted immediately upon delivery in the shade, well protected with soil, wet moss or other acceptable material and keep well-watered. Plants shall not remain unplanted for longer than 3 days after delivery.

6. Do not bind plants with wire or rope at any time so as to damage the bark or break branches. Lift and handle plants from the bottom of ball only. Plants with cracked or broken balls before or during planting operations shall be rejected.

1.7 QUALIFICATIONS

A. Fine grading, seeded lawn, sodding and planting installation shall be performed by personnel familiar with the accepted procedure of lawn construction and planting and shall be under the constant supervision of a qualified foreman.

PART 2 - MATERIALS

2.1 TOPSOIL

A. TOPSOIL stripped and stockpiled as required by Section 31 00 00, EARTHWORK, of these Specifications shall be used for part of this work. It shall be free of any admixture of subsoil, stones larger than one (1) inch, clods of hard earth, plant roots, sticks or other extraneous materials.

1. The Contractor shall be responsible for estimating the quantity of topsoil stockpiled.

B. As required, additional TOPSOIL shall be provided from an off-site source to supplement the existing topsoil stripped from the site. It shall be fertile, friable, natural loam capable of sustaining vigorous plant growth. Topsoil shall be a "sandy loam" or a "fine sandy loam" of uniform composition as determined by mechanical analysis and based on the USDA classification system. In addition it shall meet the requirements above as well as the following mechanical analysis:

Sieve Size	% Retained
1 inch	0
1/2 inch	0-3
No. 100	40-60

1. The clay content of the material passing U.S.S. No. 100 mesh shall not be greater than 60% as determined by the Bouyoucous Hydrometer or by the Decantation Method. The organic content shall be 5% to 20% as determined by the Thomas Rapid Test Method or by loss on ignition on moisture free samples dried at 100 degrees C. The pH value shall be between pH 6.0 and pH 6.5. It shall contain no toxic materials. Soluble salts shall not be greater than 75 parts per million. If soil amendments are required, they shall be added at no additional cost to the Owner.

2.2 SOIL AMENDMENTS

A. GENERAL: All soil amendments shall conform to the standards of the Association of Agricultural Chemists and shall comply with State and Federal regulations.

B. LIMESTONE, if required, shall be free flowing Agricultural Grade Dolomitic Limestone ground to such fineness that 50% will pass a 100 mesh sieve and 98% will pass a 20 mesh sieve. Limestone shall contain at least 50% total oxides and not less than 85% total carbonates.

C. ALUMINUM SULFATE, if required, shall be unadulterated commercial grade.

D. GYPSUM, if required, shall be unadulterated commercial grade Calcium Sulfate.

E. COMMERCIAL FERTILIZER shall be a complete fertilizer, uniform in composition and free flowing. At least 50% of the Nitrogen shall be derived from natural or synthetic organic sources. Available Phosphoric Acid shall be from superphosphate, bone or tankage. Potash shall be derived from Muriate of Potash containing at least 60% Potash. Percentages of Nitrogen, Available Phosphoric Acid and Water-soluble Potash in the fertilizer mix shall be based on laboratory test recommendations as approved by the Owner.

1. Fertilizer for new shrubs and trees shall be 5-10-5.
2. Fertilizer for new lawns shall be 3-1-2.

F. BONEMEAL shall be finely ground commercial raw bonemeal with 4% minimum Nitrogen and 20% minimum Phosphoric Acid.

G. ORGANIC COMPOST shall be mature leaf compost, mature composted animal manure, other aged, composted vegetable materials that meet the requirements of the EPA and the State of Massachusetts for intended use. Raw (uncomposted or unprocessed) organic matter shall not be accepted.

1. Peat moss or other material the harvesting of which depletes natural wetlands shall not be used.
2. Organic material shall contain no bulking agents, such as visible, uncomposted wood chips, and be free from hard lumps. It may be shredded or granular inform. No plastic shall be present. The material shall be free of noxious odor. Organic compost shall be tested for % organics, carbon: nitrogen ratio, ammonium nitrate, moisture content, pH, and sieve analysis and test results shall be submitted for review before use may be approved as a soil component.
3. Manure shall be well rotted, unleached cattle manure, free of harmful chemicals and other injurious substances. Manure shall be free of sawdust and refuse of any kind and shall not contain more than 25% straw, shavings, leaves or other organic material. Manure shall be not be aged more than 2 years or less than 9 months.

H. MYCORRHIZAL FUNGI shall be 'PHC PLANT SAVER 4-7-4' manufactured by Lebanon Seaboard Corporation, tel: 800-233-0628, or approved equal.

1. After plants have been installed and prior to placement of mulch, place 1 packet of "PHC Plant Saver 4-7-4" around the plant in the top 1/2" of planting soil. Work into planting soil so that the material is incorporated.

2.3 PLANTING SOIL

A. PLANTING SOIL for use in new plant beds and as backfill around new shrub and tree plantings shall consist of eight (8) parts topsoil and one (1) part organic compost by volume. It shall have a pH value between 6.0 and 6.5.

2.4 ANTI-TRANSPIRANT

A. ANTI-TRANSPIRANT shall be suitable for spray application which upon drying shall produce a gas permeable, but water retarding, colorless film, having a moisture vapor transmission value of not more than 2.5 in accordance with ASTM E96. It shall be equal to "Wilt Pruf" by Nursery Specialty Products, Inc., Greenwich Conn. Apply in accordance with manufacturer's instructions.

2.5 GRASS SEED

A. Shall be fresh, clean, dry, new crop seed which meets the standards of sra-156. Seed shall be of the following varieties, mixed in proportion by weight and testing the minimum percentages of purity and germination. Submit manufacturer's certificates of compliance.

1. Weed seed shall not exceed 0.5% by weight.
2. If special conditions exist which may warrant a variance in the above seed mixture, submit a written request to the Owner stating conditions and proposed variance. Permission will be given if, in the opinion of the Owner, the variance is warranted.

B. SEED FOR LAWNS: shall be the ‘Drought and Salt Tolerant’ custom seed mix, available at Charles C. Hart Seed Co., 304 Main St., Wethersfield, CT, tel: 860-529-2537, or approved equal. Apply seed at 8 pounds per 1,000 square feet minimum.

3. Mix contains: 30% Rhizing Moon Turftype Tall Fescue, 30% Nightcrawler Turf Type Tall Fescue, 20% Tumalo Kentucky Bluegrass, 20% Doubletime Perennial Ryegrass.

2.6 ALTERNATE: SODDED LAWN

A. New Sod shall be grown from fresh, clean, dry, new crop seed which meets the standards of SRA-156. Sod shall be the 'Black Beauty' sod available from Sodco, Slocum RI, tel: 800-341-6900, or approved equal. Sod shall be of the following varieties:

1. 70% Tall Fescue, 20% Bluegrass, 10% Ryegrass.
2. Sod shall be provided in large rolls, or 'Big Rolls' at 4 foot widths and shall be recently cut and not dried out.

B. Submit manufacturer's certificates of compliance.

2.7 FILTER BARRIER

A. The Contractor shall keep the site erosion free throughout the duration of planting and seeding. Refer to Section 01 57 13 – Temporary Erosion and Sediment Control, of this Specification for filter barrier options. Approval of the method by Owner does not free Contractor of responsibility for controlling erosion.

2.8 PLANT MATERIALS

A. PLANTS shall be of specimen quality, exceptionally heavy, symmetrical, tightly knit plants so trained or favored in development and appearance so as to be unquestionably and outstandingly superior in form, number of branches, compactness and symmetry.

1. Plants shall be nursery grown in accordance with good horticultural practices, unless specifically authorized to be collected, and grown under climatic conditions similar to those in the locality of the project for at least two years. They shall have been root pruned within the past two years.
2. Plants shall be freshly dug at time of delivery. No heeled-in plants or plants from cold storage will be accepted.
3. Plants shall be sound, healthy and vigorous, well branched and densely foliated when in leaf. They shall be free of disease, insect pests, eggs or larvae and shall have healthy, well developed fibrous root systems. They shall be free from physical damage or adverse conditions that would prevent thriving with the specified result.
4. Plants shall be true to species and variety and shall conform to the measurements specified in the Plant List except that plants larger than specified may be used without an increase in Contract price if approved by the Owner. Substitutions of plant materials will not be permitted unless authorized in writing by the Owner.
5. Plants shall be measured when branches are in their normal position. Height and spread dimensions specified refer to the main body of the plant and not from branch tip to tip.
6. If a range of size is given, no plant shall be less than the minimum size and not less than 50% of the plants shall be as large as the upper half of the specified range. The measurements specified are the minimum size acceptable and are the measurements after pruning where pruning is required.
7. Plants that meet the measurements specified, but do not possess a normal balance between height and spread shall be rejected. Thin, poorly branched or sparsely rooted plants will be rejected, regardless of whether they meet the minimum technical requirements of ASNS.
8. Container grown material shall have sufficient roots to hold the soil together, firm and intact after removal, without being root bound.
9. In case of any discrepancy between the Plant List and the Planting Plan, the Planting Plan will govern.

2.9 MULCH FOR PLANTED AREAS

A. MULCH for planting shall be shredded pine bark, passing a one inch square mesh and retained on a 1/8 inch square mesh. Moisture content shall not exceed 35%. Mulch shall contain no dyes.

2.10 WOOD CELLULOSE FIBER MULCH

A. Mulch to cover hydroseeded areas with slopes flatter than ten to one (10:1) 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.

1. Moisture content shall not exceed 10 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.
2. The mulch shall be of such character that the fiber will be dispersed into a uniform slurry when mixed with water. It shall be nontoxic to plant life or animal life.
3. 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.

2.11 GUYING APPARATUS

A. WOOD STAKES shall be 2” x 2” x 8 feet in length from sound Cedar pointed at one end and reasonably free of knots. Binding and guying shall be with biodegradable webbing. Stake fastenings shall be galvanized 10 penny nails. Trees shall not be wrapped.

2.12 WATER

A. WATER shall be free of substances harmful to plant growth. Contractor shall provide all labor and water required to establish turf and plantings. During the maintenance period the Contractor shall water as required to insure that a minimum of one inch of water per week is applied to all turf areas and plant beds and that soil moisture is maintained to a depth of two inches or greater at all times.

1. The Contractor shall furnish sufficient watering equipment to maintain required water levels in the soil.

PART 3 - INSTALLATION

3.1 PREPARATION OF SITE

A. Fully protect all trees and other site features to remain in the construction area during these operations. Remove existing lawn vegetation in areas of new seeded lawn and scarify surface of areas to receive topsoil by mechanical means using caution not to disturb or damage existing tree roots. Thoroughly till the subgrade to a depth of 6 inches by an approved method. Aerate in different directions such that each area receives at least 4 passes by the aerator. Break up resulting plugs with a power rake or other approved means.

B. After the subgrade of the areas required to be seeded or planted has been brought to the grades shown on the Drawings.

C. Before spreading topsoil, establish new finish grades and regrade subgrade as necessary to a true smooth slope parallel to and to the required depth below lawn areas and in new plant beds. Care shall be taken to eliminate depressions and ridges. The top 3 inches shall be free from stones, rock or other foreign matter 2 inches or greater in dimension. Subgrade shall be inspected and approved by the Owner before the placing of topsoil.

D. Spread topsoil to meet finish grades smoothly and evenly. Provide sufficient grade stakes to insure correct line and grade of finished grade. Where no grades are shown, provide a smooth and continual grade between existing or fixed controls and elevations shown on the Drawings.

1. Thickness of topsoil in all new seeded areas shall be **6" minimum** measured after natural settlement and light rolling. Place topsoil only when it can be followed by seeding operations within a 1 week timeframe. Mechanically remove any weed growth prior to seeding. Do not permit weed growth to go to seed.

3.2 ADDITION OF SOIL AMENDMENTS

A. After the topsoil in lawn areas has been spread and graded, apply soil amendments at the rate recommended in the topsoil analysis. Apply limestone at least 5 days prior to application of fertilizer. Apply commercial fertilizer within 10 days of seeding or planting. In plant bed areas, organic compost shall be incorporated with topsoil prior to spreading in bed.

B. Thoroughly and evenly incorporate soil amendments into the soil to a depth of 4 inches by discing or other approved method. In areas inaccessible to power equipment, use hand tools. After the incorporation of soil amendments into the soil, fine grade the bed to remove all ridges and depressions, and clear the surface of all stones one inch or more in diameter and other debris. Remove excessive quantities of smaller stones as directed by the Owner.

C. Prior to seeding operations request that an inspection be made of the finished topsoil areas. Do not seed until Owner approves finish topsoil grade. Slope all lawn areas to drain. Correct finished surfaces to eliminate depressions holding water.

D. Seeding or planting may be done immediately thereafter provided the bed has remained in a good friable condition and has not become muddy or hard. If it has become hard, till to a friable condition. Water dry soil to a depth of 4 inches 48 hours prior to seeding or planting.

3.3 SCHEDULE FOR SEEDING AND PLANTING

A. The actual lawn seeding and planting operations shall be done only during periods within the season which are normal for such work as determined by weather conditions and by accepted practice in this locality. At the option of, and on the responsibility of, the Contractor seeding of lawns and planting may be done under unseasonable conditions, or out of season, without additional compensation subject to the approval at the time of work and methods of operation by the Owner. Lawn maintenance will be the same as for normal planting. Plant guarantee periods remain as specified. No frozen ground planting will be allowed.

B. Seeding and Planting shall be done within the following dates:

1. Trees and Shrubs	Spring:	April 1 to May 15
	Fall:	August 15 to October 30
2. Perennials and Grasses	Spring:	April 1 to May 15
	Fall:	September 1 to October 30

3.	Seeded Lawns	Spring: Fall:	April 1 to May 15 August 15 to October 1
4.	Sodded Lawns	Spring: Fall:	April 1 to May 15 August 15 to October 1

3.4 SEEDING

A. Seed all fine graded topsoil areas as indicated on the Drawings within the limit of work not covered by paving and plant beds, and all areas disturbed by construction inside and outside the limit of work. All lawn areas disturbed outside the limit of seeding shall be prepared and seeded as specified herein at no additional cost.

1. To prevent loss of soil via water and wind erosion and to prevent the flow of sediment, fertilizer, and pesticides onto roadways, sidewalks, and into catch basins, seed loam areas within 5 Days of spreading the loam.

B. Seeding of all new seeded lawn areas shall be done using the Broadcast and/ or Hydroseeding Methods specified below. When delays in operations extend the work beyond the most favorable planting season for species designated or when conditions are such that satisfactory results are not likely to be obtained, halt work as directed and resume only when conditions are favorable or when approved alternate or corrective measures and procedures have been affected. No seeding shall be done when the ground is frozen, excessively wet or otherwise nontillable. If Contractor chooses to seed by a different method, he or she must present this alternative to the Owner's Representative for approval.

1. BROADCAST METHOD: Broadcast seed with a drop spreader evenly onto a firm seed bed. Lightly rake seed into the soil bed to increase seed to soil contact. Sow half the seed with the sower moving in one direction and the remainder with the sower moving at right angles to the first sowing. Do not broadcast seed when wind velocity exceeds 15 mph.

2. HYDROSEEDING METHOD: After seed mix has been broadcast, Hydroseeding can be started.

a. Hydroseed with wood cellulose fiber mulch at a rate of 92 pounds per 1,000 square feet or 4,000 pounds per acre.

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. Apply the slurry by a centrifugal pump using the hose application techniques from the mobile tank. Only hose application shall be permitted. At no time shall the mobile tank or tank truck be allowed onto the prepared hydroseed beds. 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 two-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. To mark the progress of the hydroseeding operation the Contractor may add 10 percent of the wood cellulose fiber mulch to the slurry.
2. For slopes flatter than ten to one (10:1) step two shall consist of a separate application of wood cellulose fiber mulch immediately following the first step of

hydroseeding noted above. Apply the wood cellulose fiber mulch at a rate of 2,000 pounds per acre.

B. In the event that the construction goes too late in the fall to allow for seeding of lawns in season, the Contractor will return in the spring to complete this work.

1. Any weed growth that has occurred on recently spread topsoil shall be removed by the Contractor prior to seeding. Seeding shall occur in season for Spring, with dates noted in this specification.

3.5 ALTERNATE: SODDING

A. Sod all fine graded topsoil areas as indicated on the Drawings within the limit of work not covered by paving and plant beds, and all areas disturbed by construction inside and outside the limit of work. All lawn areas disturbed outside the limit of sodding shall be prepared and sodded as specified herein at no additional cost.

B. Site Preparation for sodding shall be as follows:

1. Clear the site of all rocks, stones or other debris that is larger than 2-3 inches in diameter.
2. Rough grade the entire area to eliminate drainage problems by sloping the grade away from building foundations and filling low-lying areas.
3. Till the existing soil to a minimum depth of at least 2 inches before adding any topsoil or soil amendments.
4. Add topsoil, if necessary, to achieve a total topsoil depth of 6 inches.
5. Test the soil pH according to the guidelines described at http://www.umass.edu/plsoils/soiltest/brochlink1.htm. Follow the recommendations regarding lime or gypsum addition to correct pH discrepancies.
6. Apply "starter fertilizer" that is high in phosphate, at a rate recommended for the particular product. Typical starter fertilizer recommendations are (N-P-K) of 10-10-10 or 19-19-19. Lightly incorporate this starter fertilizer into the top 2-3 inches of topsoil to avoid root injury.
7. Lightly tamp or roll the topsoil to settle the surface and create an ideal surface for installing the sod.

C. Sod Installation shall be done on the same day that sod is delivered to the project site. All soil preparation in new lawn areas shall be completed prior to sod delivery. Installation shall be as follows:

1. Prior to placing sod, dampen soil.
2. Start laying sod at a straight line such as a driveway or walk.
3. Lay out the sod as you would a rug or tiles. Make sure all joints are butted tightly together - without overlapping or spaces between strips of sod.
4. Stagger the joints in each row such that joints are not lined up.
5. Use a large sharp knife for shaping sod around trees, at flower beds or along borders.
6. Completely soak the sod with at least 1" of water. Start watering 20 minutes after the first strip is laid.
7. Roll the sod to smooth out small bumps and air pockets to ensure good contact with the soil and pat in place.
8. Newly laid sod should not be walked on.
9. Using a lawn roller, press out any air pockets that may have been missed under the sod, first in one direction, and a second time perpendicular to the first.
10. Continue rolling the sod, crossing the horizontal rolls with vertical rolls. You're rolling a grid pattern.
11. All newly placed sod shall be watered within 30 minutes of placement.

D. Watering:

1. Water sod daily for the first week in the morning. Avoid walking on sod.
2. After the first week, reduce the irrigation schedule to every other day. Water twice per week as the sod begins to take root.
3. Once the grass grows to roughly three inches high, mow with a push mower, not a riding mower.
4. Fertilize the lawn after first mowing.

3.6 MULCHING AT NEW AND EXISTING TREES

A. All new and existing trees located within the limit of work shall be mulched with five foot diameter circles of shredded bark mulch at two inch depth. Mulch shall be held a minimum of 12” away from trunks of trees.

3.7 WOOD CELLULOSE FIBER MULCH

A. Mulch to cover hydroseeded areas with slopes flatter than ten to one (10:1) 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 10 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 a 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.

3.8 PLANTING

A. Inform the Owner when planting will commence and the anticipated delivery date of plant material. Failure to notify the Owner in advance, in order to arrange proper scheduling, may result in loss of time or removal of any plant or plants not installed as specified or directed.

B. EXCAVATION OF PLANT PITS:

1. Stake out on the ground locations for plants and obtain approval of Owner before excavation is begun. Make adjustments in locations as directed.
2. Establish finish grades for new plant beds and tree pits. Excavate to depths required and regrade subgrade as necessary. Separate subgrade soils from upper "topsoil" portions and remove subgrade soils immediately wherever encountered during planting operations. Loosen top 6 inches of subgrade in pits and beds immediately prior to placing planting soil.
3. If stone, underground construction work, tree roots, poor drainage or obstructions are encountered in the excavation of plant pits, alternate locations may be selected by the Owner without additional cost. Where locations cannot be changed as determined by the Owner submit cost required to remove obstructions to a depth of not less than 6 inches below the required pit depth. Proceed with work only after approval of Owner.
4. Notify Owner in writing of all soil or drainage conditions which the Contractor considers detrimental to the growth of plant material.

C. PLANTING OPERATIONS FOR TREES, SHRUBS, PERENNIALS AND GRASSES

1. Set plants at the same relationship to finished grade as they bore to the ground from which they were dug. After settlement, the crown of the plant ball shall not be more than one inch lower than the surrounding finished grade. Backfill planting soil in layers of not more than 8 inches and tamp each layer before the next layer is placed. When plants have been backfilled approximately 2/3 full, water thoroughly before installing remainder of planting soil to top of bed, eliminating all air pockets. Do not backfill beds with planting soil until the exact location of all plants is approved by the Owner.
2. Set plants in the center of pits, plumb and straight. Brace rigidly in position until the planting soil has been tamped solidly around the ball and roots. Cut ropes or strings from top of ball after plant has been set. Remove majority of burlap wrapping from around ball.
3. Mulch and water all plants immediately after planting. Flood plants with water twice within 24 hours of planting. Smooth planting areas to conform to specified grades after full settlement has occurred and mulch has been applied. Form mulch saucers around trees planted in lawn areas.
4. After plants have been installed and prior to placement of mulch, place 1 packet of “PHC Tree Saver” in the top ½” of planting soil. Work into planting soil so that the material is incorporated.

D. FERTILIZING

1. For Spring planting only add commercial fertilizer to the planting soil at the rate recommended in the topsoil analysis. Mix thoroughly.
2. Fertilize Fall planting at time of planting. Place fertilizer for plant material over planting area and work into upper soil layer. Use commercial fertilizer at the following rates:

Trees:	2 pounds per inch of caliper
Plant Beds:	4 pounds per 100 square feet

E. PRUNING

1. Prune new plants only at time of planting and in accordance with American Association of Nurserymen standards in such a manner as to preserve the natural character of the plant. Pruning shall be done by experienced personnel under the supervision of the Owner.
2. Remove all dead wood, suckers and badly bruised or broken branches. In addition, remove approximately 1/4 of all small branching leaf canopy of deciduous plants by thinning out and shortening branches. Do not cut the leader. Trees with leaders removed shall be rejected. Use only clean sharp tools. Make all cuts flush with the trunk or branch.

F. CLEANUP: Upon completion of planting and pruning operations, remove all excess soil and debris from the site and repair any damage caused by these operations.

3.9 PLANT BEDS

A. New plant beds shall be edged in a smooth, continuously curving line as demonstrated on site, and as shown on the Drawings.

1. New plant beds shall be mulched with a 2” depth of mulch.
2. New plant beds will have a minimum twelve inch depth of planting soil.

3.10 PLANTING MAINTENANCE AND PROTECTION

A. Maintenance and protection shall begin immediately upon completion of planting and operations and after each plant is planted and shall continue until acceptance or for at least 30

days or as long as necessary to substantial completion, whichever is later with the following requirements.

1. Maintenance of new planting shall consist of pruning, watering, cultivating, weeding, mulching, resetting plants to proper grades and/or upright position, tightening and repairing of guys and restoration of planting saucers.
2. Maintenance shall begin immediately after an area is planted and shall continue until final acceptance. The minimum maintenance period shall be 90 days after completion of the planting of all plant materials.
3. Furnish and apply such pesticides as are necessary to keep these areas free of insects and disease. Pesticides shall be approved by the Owner prior to use. Use in accordance with the specifications of the prevailing Public Health Authority.
4. Protect planting areas and plants at all times against trespassing and damage of all kinds for the duration of the maintenance period. If any plants become damaged or injured, treat or replace them as directed by the Owner at no additional cost to the Owner.

3.11 LAWN MAINTENANCE AND PROTECTION

A. Maintenance and protection shall begin immediately upon completion of seeding operations and shall continue until acceptance or for at least 30 days or as much longer as necessary to establish a uniform stand of the specified grasses or until substantial completion, whichever is later with the following requirements.

1. In the event that lawn operations are completed too late in the Fall for adequate germination and/or growth of grass, maintenance shall continue into the following Spring.
2. Maintenance of lawn areas shall consist of keeping the grass in a healthy growing condition and shall include replacements, watering, weeding, cultivating, fertilizing, re-seeding as necessary to establish a uniform and knitted stand of the specified grasses and mowing.
3. During the maintenance period, any decline in the condition of seeded areas shall require immediate action to identify potential problems and to undertake corrective measures.
4. Reseed areas greater than one foot square which fail to show a uniform stand of grass. To be acceptable, a stand of grass shall have a uniform count of at least 100 plants per square foot.
5. In seeded areas, keep soil moist during germination period. After germination, supplement natural rainfall to produce a total of 2 inches per week. Water lawns not less than twice per week until acceptance.

B. 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. In seeded areas, Contractor shall keep soil continuously moist during the two to three week germination period. After germination, supplement natural rainfall to produce a total of 2 inches per week. Water lawns not less than twice per week until acceptance or as often as necessary to maintain moist soil to a depth of at least 2 inches for newly seeded areas.
2. At no time shall a tank truck be allowed on the newly seeded lawns and plant beds.

C. PROTECTION

1. Protect new tree installations, plant beds and new seeded lawn areas at all times against trespassing and damage of all kinds for the duration of the maintenance period. If any

plants become damaged or injured, treat or replace them as directed by the Owner's Representative at no additional cost to the Owner.

a. Newly seeded lawn areas shall be protected by a 4-foot high barrier of Tenax 4 ft. x 50 ft. Saf-T-Sno HD Snow Fence, 4 ft. HDPE snow fence, or approved equal. Color shall be orange or red.

2. Provide additional temporary protection fences and barriers in other locations where deemed necessary.
3. Remove temporary protection devices at the completion of maintenance period.

D. MOWING

1. Do not attempt first mowing of lawn areas until newly seeded areas reach 2-1/2 inches in height. Do not remove more than 40% of the grass leaf in initial or subsequent mowings. Maintain grass at 2 inches in height. Remove grass clippings. Lawns shall receive at least 3 mowings before acceptance. Meadow and swale seeded areas shall have one mowing prior to end of the summer season.

3.12 INSPECTION AND ACCEPTANCE

A. At the end of the maintenance and protection period, submit a written request to the Owner to inspect all work for acceptance at least 10 calendar days before the anticipated date of inspection.

B. Until this portion of the work is finally accepted, the Contractor shall be required to repair and replace any lawn area that is defective or becomes damaged when, in the judgment of the Owner, such defects or damages are the result of poor workmanship or failure to meet the requirements of the specifications. The cost of necessary repairs or replacements shall be borne by the Contractor.

C. Acceptance of plant material by the Owner shall be for general conformance to the specified size, character and quality and shall not relieve the Contractor of responsibility for full conformance to the Contract Documents including correct species.

D. If a substantial number of plants are sickly or dead at the time of inspection, acceptance will not be granted, and the Contractor's responsibility for maintenance of all plants shall be extended until replacements are made. Replacements shall conform in all respects to the Specifications for new plants and shall be planted in the same manner.

E. The Owner will be responsible for the maintenance of new lawns and planting upon acceptance of the work and continuing through the guarantee period.

3.13 GUARANTEE PERIOD AND REPLACEMENTS

A. The guarantee period for plant material shall begin at the date of acceptance. All plant material shall be guaranteed by the Contractor, for a period of one year from the date of acceptance, to be in a good healthy and flourishing condition.

B. Lawn turf installed in the fall shall be guaranteed until the spring.

C. Replace without cost to the Owner, and as soon as weather permits, and within a specified planting period, all dead plants and all plants not in a vigorous, thriving condition, as determined by the Owner during and at the end of the guarantee period. Plants shall be free of dead or dying branches and branch tips, and shall bear foliage of a normal density, size and color. Replacements shall closely match adjacent specimens of the same species.

Replacements shall be subject to all requirements stated in this Specification. Make all necessary repairs due to plant replacements at no additional cost to the Owner.

D. The guarantee of all replacement plants shall extend for an additional period of one year from the date of their acceptance after replacement. In the event that a replacement plant is not acceptable during or at the end of said extended guarantee period, the Owner may elect subsequent replacement or credit for each item.

E. Make periodic inspections as necessary, at no extra cost to the Owner, during the guarantee period to determine what changes, if any, should be made to the Owner's maintenance program. Submit in writing to the Owner and Owner any recommended changes.

3.14 FINAL INSPECTION AND ACCEPTANCE

A. At the end of the guarantee period, submit a written request to the Owner to inspect all guaranteed work for final acceptance at least 10 calendar days before the anticipated date for final inspection.

END OF SECTION

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SECTION 331000 - WATER UTILITIES

PART 1-GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all SECTIONS within DIVISION 1 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of Specifications.

1.2 DESCRIPTION OF WORK

A. Provide labor, materials, and equipment necessary to construct the exterior water system complete, including connections to existing pipelines and testing, all as indicated on the Drawings and as specified, including but not limited to the following:

1. Installation of ductile iron pipe, fittings, accessories, and appurtenant work, at the locations and to the lines and grades indicated on the Contract Drawings.
2. The installation of hydrants, gate valves and boxes and concrete thrust blocks.
3. Furnishing and installation of all materials required to connect to existing water mains, replace existing services, install new gate valves, remove existing gate valves, install corporation cocks, saddles, curb stops, service boxes, and abandoning of the existing water system (if applicable), all as shown on the Contract Drawings. All valves, 24 inches and larger shall be butterfly valves. All abandoned pipes shall be cut and capped at the main.
4. In accordance with 528 CMR 11.00, work on the fire protection system, including hydrants and exterior underground piping, shall be performed by a Licensed Fire Protection Sprinkler Systems Contractor. The fire protection exterior underground piping will terminate at the valved tee connection to the water distribution system. The tee and valve will not be considered part of the fire protection system work.

B. Unless otherwise indicated on the Drawings, exterior water lines shall be installed from a point 10 feet outside the building foundation walls to the potable water source

C. Related Work: The following items are not included in this Section and will be performed under the designated Sections.

1. Section 310000 – EARTHWORK for aggregate subbase and base courses and for aggregate pavement shoulders.
2. Section 328400 – IRRIGATION.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Descriptive literature showing pipe dimensions, pipe and joint materials and dimensions, and other details for each class or type of pipe or product to be furnished for this contract. All pipe furnished under the contract shall be manufactured in accordance with these Specifications.
2. Product Data: Submit manufacturer's technical product data and installation instructions for potable water system materials and products.
3. Shop Drawings: The Contractor shall submit for review shop drawings or descriptive literature for potable water system, showing piping, fittings, couplings, valves, hydrants, materials, dimensions, restrained joint calculations, joints and other details, blocks, and anchors. All hydrants and valves furnished under the Contract shall be manufactured only in accordance with the Specifications and the approved Shop Drawings.

4. At project closeout, submit record drawings of installed potable water system piping and products, in accordance with requirements of Division 1. As-Built Drawings shall be complete and shall indicate the true measurement and location, horizontal and vertical, of all new construction. As-Built drawings shall be stamped and signed by a Massachusetts Licensed Land Surveyor or Licensed Professional Engineer. The as-built plans shall also be submitted electronically as an AutoCAD drawing file (release 2010 or higher).
5. Maintenance Data: Submit maintenance data and parts lists for water system materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual in accordance with requirements of Division 1.

1.4 REFERENCE STANDARDS

A. The following standards are applicable to the work of this Section to the extent referenced herein:
1. ASTM: American Society for Testing and Materials.
2. ANSI: American National Standards Institute.
3. AWWA: American Water Works Association.
4. AASHTO: American Association of State Highway and Transportation Officials.
5. Reference is made herein to the Commonwealth of Massachusetts, Department of Transportation (MassDOT), Formerly Massachusetts Highway Department (MHD) Standard Specifications for Highways and Bridges, latest edition, hereinafter referred to as the "Standard Specifications". All references to method of measurement, basis of payment, and payment items in the "Standard Specifications" are hereby deleted. References made to particular sections or paragraphs in the "Standard Specifications" shall include all related articles mentioned therein.
6. MassDOT, Construction Standards, latest Edition with amendments, hereinafter referred to as the “Construction Standards.”
7. Commonwealth of Massachusetts State Plumbing Code, latest edition.
8. Commonwealth of Massachusetts Regulations 528 CMR 12.00 Sprinkler Contractor Licensing Regulations.
9. Town/City Water Department Regulations.

1.5 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.

1.6 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of potable water systems materials and products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five years.

B. Installer's Qualifications: Firm with at least three years of successful installation experience on projects with potable water piping work similar to that required for this project.

C. Water Purveyor Compliance: Comply with requirements of Purveyor supplying water to project, obtain required permits and inspections.

1.7 PROJECT CONDITIONS

A. Site Information: Perform site inspection and survey, research utility records, and verify existing utility locations and elevations. Verify that water system piping may be installed in compliance with Contract Drawings and referenced standards.

B. Interruption of Existing Water Distribution System: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to the requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Architect's written permission.

1.8 SEQUENCING AND SCHEDULING

A. Coordinate with interior building domestic water and fire protection system piping.

B. Coordinate with other utility work.

C. The Contractor is responsible for developing a sequence of work to maintain existing services in operation until the new services are operational.

D. The Contractor is responsible for coordinating and scheduling the inspection of the work by the jurisdictional authority. All permits and inspection costs and fees shall be included in the bid prices and no additional costs will be paid to the Contractor.

PART 2-PRODUCTS

2.1 SERVICE TUBING, CORPORATIONS, STOPS, SADDLES, AND VALVE BOXES

A. Service tubing shall meet the requirements of Federal Specification WW-T 7996 and shall conform to ASTM specification B75, B68 and B88 as they apply to Type K Copper Tubing.

B. Copper Tube Size (CTS) Polyethylene Tubing for domestic water uses shall conform to AWWA C901, ASTM D3350, and ASTM D2737 and shall have a working pressure rating of 200 psi. Tracer wire shall be attached to the tubing and connected to upstream piping of the associated water meter for the water service, as applicable.

C. The Contractor shall furnish and install, including necessary taps and connections, corporation stops, CTS Polyethylene Tubing, curb stops and wastes.

D. The corporation stops shall meet the most recent revision of the AWWA standard "Threads for Underground Service Line Fittings." (AWWA C800).

E. Corporation stops shall be sized as shown on the drawings and be brass compression-type with CC thread (Mueller Brand with compression nut with set screw). Corporation stops shall open right.

F. Curb Stops: Curb stops shall be sized as shown on the drawings and be brass compression-type with drain (Mueller Brand with compression nut with set screw). Curb stops shall open right.

G. Tapping Saddles: Service connections shall be tapped with Size 2" X 8" double strap service saddles.

H. Fittings and Boxes: Service boxes shall be cast iron. Extension service boxes of the required length and having slide-type adjustment shall be installed at all service box locations. The boxes shall have housings of sufficient size to completely cover the curb stop and shall be complete with identifying covers

I. Service boxes shall be 2 ½" Buffalo Style, heavy cast iron, tar coated, sliding type, consisting of three (3) pieces; a flanged bottom piece, a flanged top piece and bolted cover with the word "water" cast on the top. A minimum 6-inch overlap is required between sliding sections. The boxes lengths shall be as necessary to suit ground elevation.

2.2 IDENTIFICATION

A. Detectable Underground Warning Tapes: Acid and alkali-resistant polyethylene plastic film warning tape, 6-inches wide by 4-mils. minimum thickness, with continuously printed caption in black letters "CAUTION - xxxxx LINE BURIED BELOW." The text and color of the tape shall be as shown in the table below. The tape shall have a metallic core encased in a protective jacket for corrosion protection and be detectable by a metal detector when the tape is buried up to 2.5-feet deep.

Color	Utility
Safety Red	Electric
High Visibility Safety Yellow	Gas, Oil, Steam
Safety Alert Orange	Telephone, Communications, Cable Television
Safety Precaution Blue	Water System, Irrigation
Safety Green	Sanitary Sewer, Storm Sewer

PART 3-EXECUTION

3.1 INSPECTION

A. General: Examine areas and conditions under which potable water system's materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Engineer.

B. The Contractor is responsible for the provisions and all test requirements specified in herein. In addition, all pipe and appurtenances may be inspected at the plant for compliance with these specifications by an independent testing laboratory.

C. All tests shall be made in accordance with the methods prescribed by the above-mentioned AWWA Standards, and the acceptance or rejection shall be based on the test results.

D. Inspection of the pipe and appurtenances may also be made after delivery. The pipe and appurtenances shall be subject to rejections at any time on account of failure to meet any of the specifications requirements, even though samples may have been accepted as satisfactory at the place of manufacture.

E. Pipe which does not conform to the requirements of this contract shall be immediately removed and replaced by the Contractor at no cost to the Owner.

3.2 HANDLING PIPE

A. The Contractor shall take care not to damage pipe by impact, bending, compression, or abrasion during handling, and installation. Joint ends of pipe especially shall be kept clean.

B. Pipe shall be stored above ground at a height no greater than 5-feet, and with even support for the pipe barrel.

C. Only nylon protected slings shall be used for handling the pipe. No hooks, chains or bare cables will be permitted.

D. Gaskets shall be shipped in cartons and stored in a clean area, away from grease, oil, heat, direct sunlight and ozone producing electric motors.

3.3 INSTALLATION OF PIPE AND PIPE FITTINGS

A. The Contractor shall provide all adapters and fittings such as transition couplings, as determined in the field, necessary to complete all cross connections, whether or not specifically stated in the Contract Drawings and Specifications.

B. Care shall be taken in loading, transportation, and unloading to prevent injury to the pipe or coatings. Pipe or fittings shall not be dropped. All pipe and fittings shall be examined before placement, and no piece shall be installed which is found to be defective. Any damage to the pipe coatings shall be repaired as directed by the Engineer or Owner's Representative.

C. If any defective pipe is discovered after it has been placed, it shall be removed and replaced with a sound pipe in a satisfactory manner by the Contractor, at his own expense. All pipe and fittings shall be kept clean until they are used in the work, be thoroughly cleaned before placement, and when placed, shall conform to the lines and grades required. Ductile iron pipe and fittings shall be installed in accordance with requirements of AWWA Standard Specification C600 except as otherwise provided herein. A firm even bearing throughout the length of the pipe shall be constructed by compacting sand gravel borrow around the pipe and up to 18 inches above the pipe.

D. Blocking will not be permitted.

E. A minimum horizontal separation of ten (10) feet shall be maintained between and existing, proposed or relocated sewer and the new water main. The distance shall be measured edge to edge. In cases where it is not practical to maintain a ten-foot separation, it is permitted to install a water main closer to a sewer, provided that the water main is laid in a separate trench or on an undisturbed earth shelf located eighteen (18) inches above the top of sewer. Where the horizontal clearance is less than ten (10) feet or the vertical clearance is less than eighteen (18) inches and the sewer crosses under the water main, both water main and sewer main shall be constructed of mechanical joint cement lined ductile iron pipe for 10-feet on either side of the crossing. One (1) full length of water pipe shall be centered over the sewer at the crossing. If the sewer crosses over the water main, regardless of the vertical separation, both pipes shall be concrete encased for a distance of ten (10) feet to either side of the respective centerline.

F. Provide minimum cover over piping of 5-feet below finished grade.

G. Extend water systems from the water main located within the public way and terminate potable water piping 10-feet 0-inches from the building foundation. Provide temporary pipe plug for piping extension into building if required by construction progress.

H. All pipes shall be sound and clean before placement. When pipe laying is not in progress, including lunchtime, the open ends of the pipe shall be temporarily closed by watertight plug or other acceptable means. Alignment shall be maintained during placement. The deflection at joints shall not exceed sixty percent of that recommended by the manufacturer. Fittings, in addition to those shown on the plans, shall be provided, if required, in crossing utilities, which may be encountered upon opening the trench. Solid sleeves shall be used only where allowed by the Engineer.

I. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of pipe to be used with a push-on type bell shall be beveled to conform to the manufactured spigot end. Cement lining shall be inspected for damage and shall be re-mortared as required to ensure a continuous lining.

J. Mechanical joint restraints shall be used for all valves, bends, hydrants and piping section less than 50 feet. The contractor shall restrain all pipe runs to the lengths indicated on the approved restrained joint calculation shop drawings.

K. Jointing of ductile iron push on pipe and fittings shall be done in accordance with the printed recommendations of the manufacturer and as specified. The last 8 inches of the outside of the spigot end of pipe and the inside of the bell end of pipe shall be thoroughly cleaned. The joint surfaces and the gasket shall be painted with a lubricant just prior to making up the joint. The spigot end shall then be gently pushed home into the bell. The position of the gasket shall be checked to ensure that the joint has been properly made and is watertight. Care shall be taken not to exceed the manufacturer's recommended maximum deflection allowed for each joint.

1. Jointing Ductile Iron Pipe (Push-On Type): Push-on joints shall be made in strict accordance with the manufacturer's instructions. Pipe shall be laid with bell ends looking ahead. A rubber gasket shall be inserted in the groove of the bell end of the pipe, and the joint surfaces cleaned and lubricated. The plain end of the pipe to be entered shall then be inserted in alignment with the bell of the pipe to which it is to be joined, and pushed home with a jack or by other means. After joining the pipe, a metal feeler shall be used to make certain that the rubber gasket is correctly located.
2. Jointing Mechanical Joint Fittings: Mechanical joints at valves, fittings, and where designated shall be installed in accordance with the "Notes on Method of Installation" under ANSI Specification A 21.11 and the instructions of the manufacturer. To assemble the joints in the field, the Contractor shall thoroughly clean the joint surfaces and rubber gasket with soapy water before tightening the bolts. Bolts shall be tight to the specified torque. Under no condition shall extension wrenches or pipes over handles or ordinary ratchet wrenches be used to secure greater leverage.

L. Installation and jointing of ductile iron pipe shall be in accordance with AWWA C600, Sections 9b and 9c, latest revision, as applicable.

M. Service tubing shall be installed with minimum 6-inches of sand bedding and 12-inches sand cover. Service tubing shall have a minimum total cover of 5 feet.

3.4 INSTALLATION OF VALVES AND APPURTENANCES

A. Cleaning and Prime Coating Valves and Appurtenances (Except Epoxy Coated Valves)

1. Prior to shop prime coating, all surfaces of the valves and appurtenances shall be thoroughly clean, dry, and free from all mill-scale, rust, grease, dirt, paint and other foreign substances to the satisfaction of the Engineer or Owner’s Representative.
2. All ferrous surfaces shall be sand blasted or pickled according to SSPC-SP6 or SSPC-SP8, respectively.
3. All gears, bearing surfaces and other surfaces not to be painted shall be given a heavy coat of grease or other suitable rust resistant coating unless otherwise specified herein. This coating shall be maintained as required to prevent corrosion during any period of storage and installation and shall be satisfactory through the time of final acceptance.

B. Installation

1. All valves and appurtenances shall be installed in the location shown, true to alignment and rigidly supported. Any damage to the above items shall be repaired before they are installed.

2. Care shall be taken to prevent damage to valves and appurtenances during handling and installation. All materials shall be carefully inspected for defects in workmanship and materials, all debris and foreign material cleaned out of valve openings, etc., and all operating mechanisms operated to check their proper functioning, and all nuts and bolts checked for tightness. Valves and other equipment that does not operate easily, or are otherwise defective, shall be repaired or replaced.

C. Shop Painting Valves and Appurtenances

1. Interior and exterior surfaces of all valves which are not factory epoxy coated shall be given two coats of shop finish of an asphalt varnish conforming to AWWA C504 for Varnish Asphalt. The pipe connection openings shall be capped to prevent the entry of foreign matter prior to installation.

D. Buried Valves

1. Install valves as indicated with stems pointing up. Provide valve box over underground valves. Buried valves and boxes shall be set with the operating stem vertically aligned in the center of the valve box. Valves shall be set on a firm foundation and supported by tamping selected excavated material under and at the sides of the valve.

E. Valve Boxes

1. Valve boxes shall be installed vertically, centered over the operating nut, and if they are within the limits of the roadway or within limits where the plowing of snow will take place in the winter, the tops of the boxes shall be set ½" below the top of the finished grade. In locations where these boxes are not likely to be disturbed, the tops shall be set flush with the adjoining ground. Boxes shall be adequately supported during backfilling to maintain vertical alignment.

F. Corporation Cocks

1. The tapping machine shall be rigidly fastened to the pipe as near the horizontal diameter as possible. The length of travel of the tap should be so established that when the stop is inserted and tightened with at 14" wrench, not more than one to three threads will be exposed on the outside. When a wet tapping machine is used, the corporation stop shall be inserted and tightened in accordance with the manufacturer's specifications.

3.5 BACKFILLING

A. General: Conduct excavation and backfill operations for utility installations in accordance with 310000 – EARTHWORK, local requirements, and the contract documents.

B. Initial backfill shall be placed evenly on both sides of the pipe to distribute the load and not to cause movement or deflection of the pipe.

3.6 FIELD QUALITY CONTROL

A. Testing of Water Main/Service:

1. Prior to pressure testing, the entire line shall be water jetted to remove any rocks or debris that may have inadvertently entered the pipe during construction.

2. The Contractor in accordance with AWWA C651-99 specifications or latest revision will make pressure and leakage tests thereof, to determine that the ductile iron pipe is structurally safe and free of excess leakage. Pipeline shall be subject to a hydrostatic test of 150 pounds per square inch (psi) or 150% of the static pressure, whichever is greater. The Contractor shall furnish all equipment, materials, and labor for testing. Testing shall be done between valved off sections in approximately 1000-foot maximum section of the main. The Contractor shall furnish at his own expense the water needed for all water main testing.

3. Once the pipeline section has been filled at normal pressure and all entrapped air removed from the line, the Contractor shall raise the pressure to the approved test pressure by a special pressure pump taking water from a small tank of proper dimensions for satisfactorily measuring the rate of pumpage into the pipeline. The pipe shall maintain this pressure, within 5 psi, for a minimum of two hours during which time the line shall be checked for leaks. The measured water leakage shall not exceed the maximum allowed leakage as determined by the following equation for the section under test:

$$L = SDP^{1/2} / (133,200)$$

Where: L = Allowable leakage, gallons per hour
S = Length of pipe section tested, feet
(1,000-foot maximum)
D = Nominal pipe diameter, inches.
P = Average test pressure (psi)

Should leakage exceed this rate, the Contractor shall immediately locate the leak or leaks and repair same at his expense. Pipe shall be flushed and chlorinated when leakage does not exceed above standard. Approval does not absolve the Contractor from his responsibility if leaks develop within the new main or water services (to curb box) later within the period of warranty.

B. Testing of Fire Protection Service:

1. Testing of fire protection services shall conform to the most current NFPA requirements.

C. Chlorinating and Flushing:

1. Prior to chlorination, the Contractor shall properly flush mains. In general, flushing shall be performed at a flow rate required to achieve a minimum velocity of 2.5-feet per second (approximately 900 GPM in a 12-inch diameter main and 400 GPM in 8-inch diameter main). Flushing shall be performed for a sufficient period of time to allow for a minimum of 3 volume changes of water in the main (approximately 20 minutes per 1,000-foot of 8-inch main at the above flow rate).
2. Chlorinating shall be accomplished by pumping a chlorine solution into the mains. Water shall be allowed to enter the new water mains until the mains are full of a solution containing 25-ppm available chlorine. The valves shall then be closed and the chlorinated water allowed to stay in the mains for 24 hours. At the end of this period, the chlorine residual shall be at least 10 mg/l. If it is less than 10 mg/l measured, Contractor shall flush and rechlorinate the mains at no cost to the Owner. All valves and hydrants shall be operated to ensure their proper disinfection and shall be manipulated to prevent superchlorinated water from entering the existing distribution system. After this period, the Contractor shall flush the mains until clear, clean water is being discharged.
3. Chlorinating and flushing shall be done in accordance with AWWA C651-99 Specifications.
4. Twenty-four hours after the main has been flushed of chlorinated water, bacteriological samples shall be taken. Water samples shall be taken from corporation stops along the length of the water main. A minimum of two (2) samples shall be taken, per 3,000 foot of pipe or on each street, whichever is greater, each in duplicate, in sterile bottles and sent to a State approved private laboratory for analyses. The Contractor shall perform all necessary work including delivery of samples to a certified laboratory, and shall include the cost of sampling and analysis in his bid price. The results of the tests on these samples will determine the acceptance of the work and allow these new mains to

be connected to the District's system. The failure of any sample to pass the laboratory tests shall require the Contractor to reflush and rechlorinate the mains and resample and test the water until acceptable results are obtained, all at no additional cost to the Owner.

5. The Contractor shall submit a Disinfection report detailing the following:
   a. Type and form of disinfectant used.
   b. Date and time of disinfectant injection start and time of completion.
   c. Test locations.
   d. Initial and 24-hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
   e. Date and time of flushing start and completion.
   f. Disinfectant residual after flushing in ppm for each outlet tested.
6. The Contractor shall submit a Bacteriological Report detailing the following:
   a. Date issued, project name, and testing laboratory name, address, and telephone number.
   b. Time and date of water sample collection.
   c. Name of person collecting samples.
   d. Test locations.
   e. Initial and 24-hour disinfectant residuals in ppm for each outlet tested.
   f. Coliform bacteria test results for each outlet tested.
   g. Certification that water conforms, or fails to conform, to bacterial standards.
7. Contractor shall note that work under this Contract shall NOT be considered completed until satisfactory installation and testing of the water mains have been completed.

3.7 FINAL INSPECTION

A. Final inspection and acceptance of pipe, valves, appurtenances, and hydrants shall be made by the Owner's Representative and the utility owner having jurisdiction of the particular system. Prior to placing the systems in service, all components shall be inspected, with the Owner’s Representative present, to ensure that no debris or other contaminants are present. If necessary, the Contractor shall clean and flush piping.

B. The Contractor is responsible for coordinating and scheduling the inspection of the work by local jurisdictional authorities. No additional payment will be made for inspections and permits required in the performance of the work.

END OF SECTION

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SECTION 33 40 00 - STORM DRAINAGE UTILITIES

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all SECTIONS within DIVISION 1 – GENERAL REQUIREMENTS, which are hereby made a part of this section of Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials, and equipment necessary to construct the storm drainage system complete, including connections to existing structures and testing, as indicated on the Drawings and as specified.

B. Unless otherwise indicated on the Drawings, building drain service lines shall be installed from a point 10 feet outside the building foundation walls to the point of disposal.

C. Related Work: The following items are noted and included in this Section and will be performed under the designated sections:

1. Section 310000 – EARTHWORK for soil materials, excavating, backfilling, and site grading and removal of site utilities.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product Data: Submit manufacturer's technical product data and installation instructions for storm drain system materials and products.
2. Submit descriptive literature for piping, fittings, couplings, and appurtenances showing pipe dimensions, pipe and joint materials and dimensions, and other details for each class or type of pipe or product to be furnished for this contract. All pipe furnished under the contract shall be manufactured in accordance with these Specifications.
3. Submit shop drawings for storm drain systems, showing piping and manhole materials and sizes.
4. Submit shop drawings of complete layout of detention/retention structures, including all fittings and appurtenances.
5. The precast concrete structure shop drawing submittals for the manholes, catch basins, vaults, and tanks shall contain erection drawings showing connections, cast-in items, waterproofing details, lifting hooks, and production drawings showing elevations, sections, and details indicating sizes and quantities of reinforcement.
6. Submit shop drawings for structure frames, grates, and covers.
7. Filter fabric: Submit the manufacturer's information.
8. For trench drains submit shop drawings showing a schematic plan of the entire trench drain system, listing all parts being provided with exact centerline dimensions suitable for installation. Copies of the manufacturer’s recommended method of installation and assembly shall be submitted for review.
9. For water quality structures and stormwater quality filter treatment structures submit shop drawings for the structure and performance. Shop drawings shall detail the structures precast concrete components, inserts, and castings. Where an external bypass is required, the manufacturer shall provide calculations and designs for all

structures, piping and any other required material applicable to the proper functioning of the system, stamped by a Professional Engineer.

10. The Contractor shall submit buoyancy calculations for storm drainage structures assuming groundwater is one (1) foot below finish grade. If buoyancy is an issue the structure(s) shall be modified to prevent uplift. All buoyancy calculations and precast concrete structure designs shall be prepared and sealed by a professional Civil Engineer licensed in the state of Massachusetts.
11. Prior to the acceptance of the storm drainage system, the Contractor shall submit to the Engineer, for review and approval, As-Built Drawings that indicate the true measurement and location, horizontal and vertical, of all new construction. As-Built drawings shall be stamped and signed by a Massachusetts Licensed Land Surveyor or Licensed Professional Engineer. The as-built plans shall also be submitted electronically as an AutoCAD drawing file (release 2010 or higher).
12. Prior to acceptance of the storm drainage system, the Contractor shall submit the results of the pipe deflection measurements and the video inspection reports.

1.4 REFERENCE STANDARDS

A. The following standards are applicable to the work of this Section to the extent referenced herein:

1. ASTM: American Society for Testing and Materials.
2. ANSI: American National Standards Institute.
3. AASHTO: American Association of State Highway and Transportation Officials.
4. Reference is made herein to the Commonwealth of Massachusetts, Department of Transportation (MassDOT), Formerly Massachusetts Highway Department (MHD) Standard Specifications for Highways and Bridges, latest edition, hereinafter referred to as the "Standard Specifications". All references to method of measurement, basis of payment, and payment items in the "Standard Specifications" are hereby deleted. References made to particular sections or paragraphs in the "Standard Specifications" shall include all related articles mentioned therein.
5. MassDOT Construction Standards, latest Edition with amendments, hereinafter referred to as the “Construction Standards.”

1.5 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.

1.6 QUALITY ASSURANCE

A. Environmental Compliance: Comply with applicable portions of local environmental agency regulations pertaining to storm drain systems.

B. Utility Compliance: Comply with the City/Town of Worcester regulations, standards, and guidelines pertaining to storm drainage system installation and inspections.

C. Plumbing Code Compliance: Comply with applicable portions of Massachusetts Plumbing Code and National Standard Plumbing Code, latest editions, pertaining to selection and installation of storm drain system's materials and products.

D. Manufacturer's Qualifications: Firms regularly engaged in manufacturing of storm drain system's products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than five years.

E. Installer's Qualifications: Firms with at least three years of successful installation experience on projects with storm drain work similar to that required for the project.

1.7 PROJECT CONDITIONS

A. Site Information: Perform site inspection and survey, research utility records, and verify existing utility locations and elevations. Verify that storm drainage system structures and piping may be installed in compliance with Contract Drawings and referenced standards.

B. Interruption of Existing Storm Drainage System: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to the requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Architect’s written permission.

1.8 SEQUENCING AND SCHEDULING

A. Coordinate with interior building storm drain system piping.

B. Coordinate with other utility work.

C. The Contractor is responsible for developing a sequence of work to maintain existing services in operation until the new services are operational.

D. The Contractor is responsible for coordinating and scheduling the inspection of the work by the jurisdictional authority. All permits and inspection costs and fees shall be included in the bid prices and no additional costs will be paid to the Contractor.

PART 2 – PRODUCTS

2.1 MANHOLES AND CATCH BASINS

A. General: Provide precast reinforced concrete structures as indicated and complying with ASTM C 478.

B. Manhole Top: Precast concrete, of concentric cone, eccentric cone, or flat slab top type, as indicated in the Contract Drawings. Tops shall be designed to meet H20 loadings.

C. Base and Riser Sections: Precast concrete, with base riser section with integral floor. Diameter, base and riser thicknesses shall be as indicated on the Contract Drawings.

D. Cement: Type II or Type III.

E. Concrete strength: 4,000 psi minimum.

F. Precast concrete sections shall have tongue and groove joints.

G. Horizontal Joints: Joints between sections of concrete structures shall be sealed with a flexible, watertight joint, made with preformed butyl rubber joint sealant conforming to ASTM

C990 or with a rubber gasket joint conforming to ASTM C443. Sealants and/or gaskets shall be installed in accordance with the manufacturer's written instructions.

H. Manhole Steps: Steps for manholes shall be non-skid raised edge-front steel reinforced polypropylene plastic type with at least 13-inch-wide stepping surface. Steps shall meet the requirements of ASTM C-478 and AASHTO M-199. Steel shall be 1/2-inch grade 60 conforming to ASTM A615 encapsulated with molded copolymer polypropylene. The polypropylene shall conform to ASTM D-4101. Rungs shall protrude no more than 6 inches from the wall. The portion of the legs to be embedded in the precast section shall have fins and be tapered to ensure a secure bond. Steps shall start a foot above the shelf of the manhole floor and continued twelve inches on center spacing up through the completed height of the unit. The steps shall finish no lower than twenty-four (24)-inches below the rim elevation. Placement into precast walls shall be by a method recommended by the supplier of the precast manhole sections. Steps shall be installed per the manufacturer's specifications.

I. Pipe Connections: Drainage structures shall have plain beveled openings to accept the type of pipe specified. Pipe openings shall be minimum size required to receive the pipe and shall be accurately set to conform to the required line and grade. Drain pipe shall be joined to the wall of the concrete manhole or catch basin with non-shrink grout or flexible manhole sleeve as indicated on the drawings. Grout mixture shall follow instructions provided by manufacturer. Flexible manhole sleeves shall be cast in the walls of the manholes during the manufacturing process. Flexible manhole sleeves shall be NPC Kor-N-Seal Pipe-to-Manhole Connector as manufactured by Trelleborg Pipe Seals Milford, Inc., Milford, NH; Z-Lok as manufactured by A-Lok Products, Inc., Tullytown, PA; Tylox CIB Series Cast-In Boot Connector as manufactured by Hamilton Kent, Winchester, TN; or approved equal.

J. Waterproofing: The exterior surfaces of precast structures shall be given two heavy coats of waterproofing concrete sealer. The material shall be Aqua-Safe Concrete Sealer as manufactured by Bay Oil Company, Chicopee, MA; Bitumastic 300M as manufactured by Carboline Company, St. Louis, MO; Sonoshield HLM 5000 as manufactured by BASF Corporation Building Systems, Shakopee, MN; ConSeal CS-1800 as manufactured by Concrete Sealants, Inc., Tipp City, OH; or acceptable equivalent products. The waterproofing material shall be applied by brush or spray and in accordance with the instructions of the manufacturer. Time shall be allowed between coats to permit sufficient drying so that the application of the second coat has no effect on the first coat.

K. Storm Drainage Brick Masonry: Bricks shall be sound, hard, uniformly burned, regular, and uniform in shape and size. Underburned or salmon brick shall not be acceptable. Only whole brick shall be used.

1. Bricks for raising manhole and catch basin frames to finished grade shall conform to ASTM C32, Grade MS.
2. Mortar shall be in conformance with ASTM C270, Type M. The mortar shall be composed of one-part Portland cement, 3-1/2 parts sand, and ¼ parts hydrated lime, by volume. Portland cement shall be ASTM C150, Type II; hydrated lime shall be Type S conforming to ASTM D207.
3. Sand shall be washed, cleaned, screened, well-graded with all particles passing a No. 4 sieve, and conform to ASTM C33.

L. Inverts in drain manholes shall be constructed of cement concrete shaped to conform accurately to size of the adjoining pipe. Side inverts and main inverts where the direction changes shall be laid out in smooth curves of the longest possible radius which is tangent, within the manhole, to the centerline of the adjoining pipe lines.

M. For all manhole depths greater than 10 feet, the inside diameter of the manholes shall be at least 5'-0".

N. Safety landings will be installed inside manholes greater than 16-feet in depth.

O. When installing manholes on existing lines and when flows cannot be diverted, drop-over manholes shall be used. Drop-over manholes shall be precast with opening cast in the sidewalls of sufficient size to fit over the existing line(s) to remain in service. Drop-over manholes shall be set on a precast or cast-in-place concrete base slab. Drop-over manholes shall be manufactured to the same requirements and dimensions as standard manholes.

2.2 CONCRETE BLOCK MANHOLES

A. Concrete block manholes shall only be utilized when it is not feasible to utilize a precast concrete manhole and then only with written approval from the Owner's Representative.

B. Concrete block drain manholes shall be minimum 48 inches inside diameter and built of standard solid manhole barrel blocks set on a concrete or precast sectional plate base. The upper 2 feet of masonry shall be built using batter blocks. All joint spaces shall be completely filled, horizontal and vertical. All block to be thoroughly wet before jointing. A leveling course of two bricks at the top shall be used to meet proper grade. Cement concrete blocks shall be machine-made solid segments conforming to the requirements for Concrete Masonry Units for Construction of Catch Basin and Manholes, ASTM-C-139. Blocks shall be 6 inches in width with the inside and outside surfaces curved to the necessary radius and so designed that the interior surfaces of the structures shall be cylindrical. The top batter courses shall be designed to reduce uniformly the inside section of the structure to the top size and shape. The blocks used in the top courses shall be designed to produce a surface 8 inches in width upon which to seat the frame.

2.3 MANHOLE FRAMES AND COVERS

A. Frames and covers shall be of cast iron conforming to the requirements of ASTM A48, Class No. 30 and shall be manufactured by General Foundries Inc., North Brunswick, New Jersey; East Jordan Iron Works (formerly LeBaron Foundry, Inc.), East Jordan, Michigan; Neenah Foundry Company, Neenah, Wisconsin; or approved equal. Manhole covers shall be machined to fit securely and evenly on the frame. Frames and covers shall be designed to accept H20 loads, have a diamond surface finish, and frame height of 6 to 9-inches. Covers shall be equal to Item Numbers 12665 and 12685 (6" and 8-1/8" frame heights, respectively) as manufactured by General Foundries Inc. Catalog numbers are provided to establish a standard of quality and configuration of castings. Covers shall bear the word "DRAIN" "WORCESTER DRAIN" in 3-inch-high letters.

2.4 CATCH BASIN FRAMES AND GRATES

A. Catch basin grates located at low points shall consist of a 24-inch square grate with a minimum frame height of 8 inches unless otherwise noted on the drawings. Frames and grates shall be of cast iron and designed to accept H20 loads. Catch Basin Frames and Grates shall be manufactured by General Foundries Inc., North Brunswick, New Jersey; East Jordan Iron Works (formerly LeBaron Foundry, Inc.), East Jordan, Michigan; Neenah Foundry Company, Neenah, Wisconsin; or approved equal. Single frames and grates shall be equal to Item Numbers 22444-SQH, 22464-SQH, and 22484-SQH (4", 6", and 8" frame heights, respectively) as manufactured by General Foundries Inc. ADA Compliant frames and grates shall be equal to Item Numbers 22444-ADA, 22464-ADA, and 22484-ADA (4", 6", and 8" frame heights, respectively) as manufactured by General Foundries Inc. Double frames and grates shall be equal to Item Numbers 24844-SQH, 24864-SQH, and 24884-SQH (4", 6", and 8" frame heights, respectively) as manufactured by General Foundries Inc. Four and three-flange frames shall be provided as required. Catalog numbers are provided to establish a standard of quality and configuration of castings.

B. Catch basin cascade frames and grates shall consist of a 24-inch square grate with a minimum frame height of 8 inches unless otherwise noted on the drawings. Frames and grates shall be of cast iron and designed to accept H20 loads. Cascade frames and grates shall be manufactured by General Foundries Inc., North Brunswick, New Jersey; East Jordan Iron Works (formerly LeBaron Foundry, Inc.), East Jordan, Michigan; Neenah Foundry Company, Neenah, Wisconsin; or approved equal. Cascade frames and grates shall be equal to Item Numbers 22444-CAS, 22464-CAS, and 22484-CAS (4", 6", and 8" frame heights, respectively) as manufactured by General Foundries Inc. Four and three-flange frames shall be provided as required. Catalog numbers are provided to establish a standard of quality and configuration of castings.

2.5 CATCH BASIN HOODS

A. All catch basins shall have hoods installed over the outlet pipe. Hoods shall be cast iron removable or hinged traps that fit over the catch basin outlet pipe. Traps shall be approximately 19-inches wide by 18-inches high and extend 11-inches from the wall of the structure. Catch Basin Hoods shall be manufactured by General Foundries Inc., North Brunswick, New Jersey; East Jordan Iron Works (formerly LeBaron Foundry, Inc.), East Jordan, Michigan; Neenah Foundry Company, Neenah, Wisconsin; or approved equal. Hoods shall be equal to Item Number MATRP as manufactured by General Foundries Inc. Catalog numbers are provided to establish a standard of quality and configuration of castings.

2.6 AREA DRAIN

A. Area drains required for this contract shall be manufactured from PVC pipe stock, utilizing a thermo-molding process to reform the pipe stock to the specified configuration. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. This joint tightness shall conform to ASTM D3212 for joints for drain and sewer plastic pipe using flexible elastomeric seals conforming to ASTM F477. The pipe bell spigot shall be joined to the main body of the area drain. A PVC cap shall be installed at the bottom of the area drain sump. The raw material used to manufacture the pipe stock that is used to manufacture the main body and pipe stubs of the surface drainage inlets shall conform to ASTM D1784 cell class 12454. Area drains shall be manufactured by Nyloplast or approved equal.

B. Grates and frames furnished for all area drainage shall be ductile iron for sizes 8", 10", 12", 15", 18" and 24" and shall be made specifically for each basin so as to provide a round bottom flange that closely matches the diameter of the surface drainage inlet. Grates for area drains shall be capable of supporting H-20-wheel loading for vehicular traffic areas or H-10 loading for pedestrian traffic areas unless otherwise noted. 12" and 15" square grates shall be hinged to the frame using pins. Metal used in the manufacture of the castings shall conform to ASTM A536 grade 70-50-05 for ductile iron. Grates shall be provided painted black. Grates in walkways shall meet ADA requirements. Grates in planting beds shall be domed grates. The grates furnished for area drains bioretention areas shall be 24" in diameter. All area drain grates should include a locking device. Area drain grates shall be manufactured by Nyloplast or approved equal.

2.7 INLINE DRAINS

A. The inline drain required for this contract shall be manufactured from PVC pipe stock, utilizing a thermos-molding process to reform the pipe stock to the furnished configuration. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. This joint tightness shall conform to ASTM D3212 for joints for drain and sewer plastic pipe using flexible elastomeric seals. The flexible elastomeric seals shall conform to ASTM F477. The pipe bell spigot shall be joined to the inline drain body by use of a swage mechanical joint. The ram material used

to manufacture the pipe stock that is used to manufacture the inline drain body and pipe stubs of the surface drainage inlets shall conform to ASTM D1784 cell class 12454.

B. The grates furnished for all surface drainage inlets shall be ductile iron grates for sizes 8", 10", 12",15", 18", and 30" shall be made specifically for each fitting so as to provide a round bottom flange that closely matches the diameter of the surface drainage inlet. Grates for inline drains shall be capable of supporting H-20-wheel loading for traffic areas or H-10 loading for pedestrian areas. 12" and 15" square grates will be hinged to the frame using pins. Metal used in the manufacture of the castings shall conform to ASTM A536 grade 70-50-05 for ductile iron. Grates shall be provided painted black.

2.8 HUB AND SPIGOT CAST IRON SOIL PIPE AND FITTINGS

A. Hub and Spigot Cast Iron pipe and fittings shall be manufactured from gray cast iron and shall conform to ASTM A74. Joints shall be made using a compression gasket manufactured from an elastomer meeting the requirements of ASTM C564. Installation shall comply with manufacturer's recommendations and applicable code requirements.

2.9 PVC DRAINAGE PIPE

A. General: Provide pipes of the following materials of class indicated. Provide pipe fittings and accessories of same materials and class as pipes with joining method, as indicated. The piping shall be manufactured by an established manufacturer of good reputation in the industry and in a permanent plant adapted to meet all the design requirements of the pipe.

B. PVC (Polyvinyl Chloride) Gravity Sewer Pipe and Fittings: ASTM D3034, SDR 35, for elastomeric gasket joints. Pipe 18 to 36 inches in diameter shall conform to ASTM F679, T-1 heavy wall. The pipe shall have a Standard Dimension Ratio (SDR) of 35 and a pipe stiffness of 46 psi.

C. Joints: PVC pipe shall have an integral wall bell and spigot push-on joint with elastomeric gaskets secured in place in the bell of the pipe. The bell shall consist of an integral wall section with solid cross section elastomeric gasket, factory assembled, securely locked in place to prevent displacement during assembly. Pipe joints shall conform to ASTM D3212 and elastomeric gaskets shall conform to ASTM F477.

D. Spigot pipe ends shall be supplied with bevels from the manufacturer to ensure proper insertion. Each spigot end shall have an "assembly stripe" imprinted thereon to which the bell end of the mated pipe will extend upon proper joining of the two pipes.

E. PVC gravity sewer fittings and accessories shall be as manufactured and furnished by the pipe supplier or approved equal and have bell and spigot configurations compatible with that of the pipe.

2.10 CORRUGATED POLYETHYLENE PIPE

A. General: Provide pipes of the following materials of class indicated. Provide pipe fittings and accessories of same materials and class as pipes with joining method, as indicated. The piping shall be manufactured by an established manufacturer of good reputation in the industry and in a permanent plant adapted to meet all the design requirements of the pipe.

1. Corrugated polyethylene pipe shall have an interior surface that is smooth and even, free from roughness, projections, indentations, offsets, or irregularities of any kind.
    a. Pipe shall conform to AASHTO M252, Type S for 4- through 10-inch diameter pipes.
    b. Pipe shall conform to AASHTO M294, Type S or ASTM F2306 for 12- through 60-inch diameter pipes.

c. Fittings shall conform to AASHTO M252, AASHTO M294 or ASTM F2306. Bell and spigot connections shall utilize a spun-on or welded bell and valley or saddle gasket meeting the watertight joint performance requirements of AASHTO M252, AASHTO M294 or ASTM F2306.

2. Pipe and fittings shall be high-density polyethylene meeting the requirements of ASTM D3350.

3. Pipe units shall have a minimum laying length of 20-feet except as otherwise indicated or allowed by the Engineer.

4. Pipe shall be installed with a minimum 12-inch cover for AASHTO H-20 loading.

B. CORRUGATED POLYETHYLENE FLARED END SECTION

1. The pipe shall have an interior surface that is smooth and even, free from roughness, projections, indentations, offsets, or irregularities of any kind. Flared end section shall be high-density polyethylene meeting ASTM D3350 minimum cell classification 213320C. Metal threaded fastening rods shall be stainless steel.

C. JOINTS ON CORRUGATED POLYETHYLENE PIPE

1. The pipe and fitting joints shall be bell-and spigot with watertight gaskets in accordance with the requirements of ASTM D3212.

2. Gaskets shall meet the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly.

3. Pipe entrances at catch basins shall be made with a mortar made with Type II cement. Mortar mixture shall follow instructions provided by cement manufacturer. Pipe connections at drain manholes and water quality structures shall be made with integral flexible rubber sleeves and Corrugated Pipe Adapters designed for use with the pipe and sleeves.

2.11 FILTER FABRIC

A. Filter Fabric used as a drainage medium shall be a needle-punched, non-woven geotextile made from polypropylene or polyethylene filaments or yarns.

B. Filter fabric shall be inert to organic chemicals commonly encountered in the soil.

C. Filter fabric shall be meet AASHTO M288 Survivability Class 2 Standards.

D. The edges of filter fabric shall overlap a minimum of one foot.

E. Filter fabric shall be in compliance with the following properties, measured as per the referenced test methods:

PROPERTY	Required Value	TEST METHOD
Grab Tensile Strength	160 lbs. (min.)	ASTM D 4632
Elongation @ Failure	50% (min.)	ASTM D 4632
Trapezoidal Tear Strength	60 lbs. (min.)	ASTM D 4533
CBR Puncture Strength	410 lbs. (min.)	ASTM D 6241
Permittivity	1.5 sec^{-1} (min.)	ASTM D 4491
Water Flow Rate	110 gal./min./SF (min.)	ASTM D 4491
Apparent Opening Size	#70 Standard US Sieve	ASTM D 4751

PROPERTY	Required Value	TEST METHOD
U.V. Radiation Stability	70% (min.)	ASTM D 4355

2.12 CRUSHED STONE

A. Crushed stone shall consist of durable crushed rock or durable crushed gravel stone, free from ice and snow, sand, clay, loam, or other deleterious or organic material. The crushed stone shall be uniformly blended and shall conform to the following requirements.

Percent Passing by Weight		
Sieve Size	**3/4-inch Stone**	**1/2-inch Stone**
1-inch	100	---
3/4-inch	90-100	---
5/8-inch	---	100
1/2-inch	10-50	85-100
3/8-inch	0-20	15-45
No. 4	0-5	0-15
No. 8	---	0-5

2.13 DRAIN COUPLINGS

A. Drain Couplings shall be pressure rated at least equal to that of the pipe. The coupling sleeve, shall be 1/4-inch minimum thickness elastomeric polyvinylchloride with a minimum tensile strength of 1500 psi. The sleeve shall fit snugly onto the pipe to be joined and be resistant to common chemicals present in storm water. Adjustable pipe clamps shall consist of a slotted band that mate with the worm gear screw and a screw housing all manufactured of stainless steel, and suitable for underground service.

2.14 CLEANOUTS

A. General: Provide cast-iron ferrule and countersunk brass cleanout plug, with round cast-iron access frame and heavy-duty, secured, scoriated cast-iron cover.

B. The drain cleanouts shall be minimum 6-inch diameter or sized to match the service pipe, whichever is greater. The cleanout shall be complete with a flush mount over. The cleanout cover shall be clearly marked “DRAIN” and shall be minimum eight inches in diameter or two inches greater than the cleanout size, whichever is greater. Cleanouts shall include a watertight cap.

2.15 IDENTIFICATION

A. Detectable Underground Warning Tapes: Acid and alkali-resistant polyethylene plastic film warning tape, 6-inches wide by 4-mils. minimum thickness, with continuously printed caption in black letters "CAUTION - xxxxx LINE BURIED BELOW." The text and color of the tape shall be as shown in the table below. The tape shall have a metallic core encased in a protective jacket for corrosion protection and be detectable by a metal detector when the tape is buried up to 2.5-feet deep.

Color	Utility
Safety Red	Electric
High Visibility Safety Yellow	Gas, Oil, Steam

Color	Utility
Safety Alert Orange	Telephone, Communications, Cable Television
Safety Precaution Blue	Water System, Irrigation
Safety Green	Sanitary Sewer, Storm Sewer

PART 3 – EXECUTION

3.1 GENERAL INSTALLATION

A. General: General Locations and Arrangements: Contract Drawings indicate the general location and arrangement of the underground storm drainage system piping. Location and arrangement of piping layout take into account many design considerations. Install the piping as indicated, to the extent practical. Any modifications to the layout of the storm drainage system shall be submitted to the Engineer for review and approval at least five days prior to the start of the affected work.

B. Install piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's recommendations, accepted practices, and utility owner’s requirements. Maintain swab or drag in line and pull past each joint as it is completed.

C. All pipe shall be laid in the dry. Adequate measures shall be taken to prevent floatation of pipe in the trench.

D. Whenever encountered within the trench, existing abandoned water, sewer, and/or drain lines shall be removed within the trench limits, unless otherwise noted. The remaining portion of the abandoned lines shall be plugged at all open ends.

E. When bell and spigot pipes are used, bell holes shall be dug in the bedding to accommodate the bells. They shall be deep enough to ensure that the bell does not bear on the bottom of the hole but shall be excessively wide in the longitudinal direction of the installation.

F. Use manholes for changes in direction, except where a fitting is indicated. Use fittings for branch connections, except where direct tap into an existing storm drain is indicated.

G. Use proper size increasers, reducers, and couplings, where different size or material of pipes and fittings are connected. Reduction of the size of piping in the direction of flow is prohibited without the written approval of the Engineer.

H. Install piping pitched down in direction of flow as indicated on the Contract Drawings.

I. Extend storm drainage system piping to connect to building drain services, of sizes and in locations indicated on the Contract Drawings.

J. Install piping in accordance with governing authorities having jurisdiction, except where more stringent requirements are indicated.

K. Acceptance of Pipe: Acceptance will be on the basis of tests specified herein before. The quality of all materials used in the pipe, the process of manufacture, and the finished pipe shall be subject to review by the Engineer. Inspection may be made at the place of manufacture, or on the work site after delivery or at both places and the pipe shall be subject to rejection at any time on account of failure to meet any of the specification requirements, even though sample pipe units may have been accepted as satisfactory at the place of manufacture. All pipe which is rejected shall be immediately removed from the project site by the Contractor.

L. Pipe Storage: Pipe sections shall not be stored on areas over the newly laid pipe or other pipelines which might be damaged by the superimposed load, and storage sections shall be restricted to approved areas.

M. Handling Pipe: Each pipe unit shall be handled into its position in the trench only in such manner and by such means, as the Engineer accepts as satisfactory. The Contractor will be required to furnish suitable devices to permit satisfactory support of all parts of the pipe unit when it is lifted.

N. Laying Pipe: Except where a concrete cradle or envelope is required, the pipe shall be laid in a crushed stone cradle. In trenches, no blocking or supporting of the piping by concrete, stones, bricks, wooden wedges, or method other than bedding the pipe on crushed stone will be permitted. Each length of pipe shall be shoved home against the pipe previously laid and held securely in position. Joints shall not be "pulled" or "cramped" without approval of the Engineer.

O. Jointing Pipe: After the pipe are aligned in the trench and are ready to be jointed, all joint surfaces shall be cleaned.

P. Alignment and Placement: All pipe shall be laid with extreme care as to grade and alignment. Each pipe shall be so laid as to form a close joint with the next adjoining pipe and bring the inverts continuously to the required grade.

1. Stakeout of drain work and setting of line and grade is the responsibility of the Contractor.
2. The Contractor shall establish centerline and offset stakes at each manhole, plus one intermediate centerline and offset stake as a check point between manholes. Laser aligning shall not be used to establish a continuous line in excess of 400-feet.

Q. Cleaning: Care shall be taken to prevent earth, water, and other materials from entering the pipeline. As soon as possible after the pipe and manholes are completed, the Contractor shall clean out the pipeline and manholes being careful to prevent soil, water and debris from entering any existing drainage system.

1. Place plugs in end of uncompleted conduit at end of day or whenever work stops.
2. Flush lines between manholes to remove collected debris.

R. Review of Completed Storm Drain System: The completed drain system shall be visually inspected by the Owner’s Representative. If the visual observation of the completed drain or any part thereof shows any pipe, manhole, or joint to be of defective work or material, the defect shall be replaced or repaired as directed by the Engineer or the Owner’s Representative. The Contractor shall coordinate and provide site access for inspection.

3.2 PVC PIPE

A. General: Install piping in accordance with governing authorities having jurisdiction, except where more stringent requirements are indicated.

B. PIPE HANDLING

1. All pipe and fittings shall be carefully handled from the truck onto the ground and into the trench or excavation so as to prevent damage to the pipe. Pipes shall be kept free of dirt and foreign material, especially on the inside. Joint ends of pipe shall especially be kept clean.
2. Pipe stored on site shall be protected from heat and direct sun light and shall be suitably ventilated.
3. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before laying, and no piece shall be installed which is found to be defective.

C. ALIGNMENT AND PLACEMENT OF PVC PIPE

1. Bedding material for the pipe must be installed with care in the area around the pipe. Bedding material must be placed to provide uniform and adequate support under pipe. Do not use blocking to bring pipe up to grade.
2. Provide bell holes at each joint to permit joint to be assembled properly while maintaining uniform pipe support.
3. Place and consolidate the bedding material under the pipe haunch to provide adequate side support while avoiding both vertical and lateral displacement of pipe.
4. Initial backfill must be completed to a point at least 12-inches over the top of the pipe and be hand placed. Use little or no tamping of initial backfill directly over the top of pipe. Compaction methods may be utilized during final backfilling.
5. No length of pipe shall be laid until the proceeding lengths of pipe have been thoroughly embedded in place, to prevent movement or disturbance of the pipe alignment.
6. Full lengths of pipe shall be used in the installation except that partial lengths may be used at the entrance to structures, and to accommodate the required locations of service connection fittings.
7. Pipe entrances to structures shall be cut flush with the inside face of the structure and cut ends of the pipe surface within the structure shall be properly rounded and finished so that there will be no protrusion, ragged edges or imperfections that will impede or affect the hydraulic characteristics of the stormwater flow. The method of cutting and finishing shall be subject to the approval of the Engineer.
8. The Contractor shall protect the installation at all times during construction. The movement of construction equipment, vehicles and loads over and adjacent to any pipe shall be performed at the Contractor’s own risk.
9. Drain pipes shall be laid to the required grades by use of a laser and target system, unless otherwise specifically approved by the Engineer.
10. Jointing of PVC drain pipe and fittings shall be done in accordance with the printed recommendations of the manufacturer and as specified. The bell end of the pipe shall be thoroughly cleaned. The joint surfaces and the gasket shall be lubricated prior to making up the joint. The position of the gasket shall be checked to ensure the joint has been properly made and is watertight. Care shall be taken not to exceed the manufacturer's recommended maximum deflection allowed for each joint.
11. PVC pipe shall be pushed home by hand or with the use of bar and block. The use of power equipment, such as a backhoe bucket, is not acceptable.
12. Field-cut pipe ends shall be cut square and the pipe surface beveled to the size and shape of a factory-finished beveled end. All sharp edges shall be rounded off.

3.3 INSTALLATION OF CORRUGATED POLYETHYLENE PIPE AND PIPE FITTINGS

A. General: Install Corrugated Polyethylene Pipe in accordance with ASTM D2321 and governing authorities having jurisdiction, except where more stringent requirements are indicated.

B. Acceptance of Pipe: Acceptance will be on the basis of tests specified herein before. The quality of all materials used in the pipe, the process of manufacture, and the finished pipe shall be subject to review by the Engineer. Inspection may be made at the place of manufacture, or on the work site after delivery or at both places and the pipe shall be subject to rejection at any time on account of failure to meet any of the specification requirements, even though sample pipe units may have been accepted as satisfactory at the place of manufacture. All pipe which is rejected shall be immediately removed from the project site by the Contractor.

C. Pipe Storage: Pipe sections shall not be stored on areas over the newly placed pipe or other pipelines which might be damaged by the superimposed load, and storage sections shall be restricted to approved areas.

D. Handling Pipe: Each pipe unit shall be handled into its position in the trench only in such manner and by such means, as the Engineer accepts as satisfactory. The Contractor will be required to furnish suitable devices to permit satisfactory support of all parts of the pipe unit when it is lifted.

E. Alignment and Placement: All pipe shall be placed with extreme care as to grade and alignment. Each pipe shall be so placed as to form a close joint with the next adjoining pipe and bring the inverts continuously to the required grade.

1. Stakeout of drain work and setting of line and grade is the responsibility of the Contractor.
2. The Contractor shall establish centerline and offset stakes at each manhole, plus intermediate centerline and offset stake as needed to ensure proper alignment and grade between manholes. Laser aligning shall not be used to establish a continuous line in excess of 400-feet.
3. Bedding material for the pipe must be installed with care in the area around the pipe. Bedding material must be placed to provide uniform and adequate support under pipe. Do not use blocking to bring pipe up to grade. Bedding shall be crushed stone.
4. Provide bell holes at each joint to permit joint to be assembled properly while maintaining uniform pipe support.
5. Place and consolidate the bedding material under the pipe haunch to provide adequate side support while avoiding both vertical and lateral displacement of pipe.
6. Initial backfill must be completed to a point at least 12-inches over the top of the pipe and be hand placed. Use little or no tamping of initial backfill directly over the top of pipe. Compaction methods may be utilized during final backfilling.
7. No length of pipe shall be laid until the proceeding lengths of pipe have been thoroughly embedded in place, to prevent movement or disturbance of the pipe alignment.
8. Full lengths of pipe shall be used in the installation except that partial lengths may be used at the entrance to structures, and to accommodate the required locations of service connection fittings.
9. Pipe entrances to structures shall be cut flush with the inside face of the structure, and cut ends of the pipe surface within the structure shall be properly finished so that there will be no protrusion, ragged edges or imperfections that will impede or affect the hydraulic characteristics of the stormwater flow. The method of cutting and finishing shall be subject to the approval of the Engineer.
10. The Contractor shall protect the installation at all times during construction. The movement of construction equipment, vehicles and loads over and adjacent to any pipe shall be performed at the Contractor’s own risk.
11. Jointing of pipe and fittings shall be done in accordance with the printed recommendations of the manufacturer and as specified. The bell end of the pipe shall be thoroughly cleaned. The joint surfaces and the gasket shall be lubricated prior to making up the joint. The position of the gasket shall be checked to ensure the joint has been properly made and is watertight. Care shall be taken not to exceed the manufacturer's recommended maximum deflection allowed for each joint.
12. Each length of pipe shall be pushed home by hand or with the use of bar and block. The use of power equipment, such as a backhoe bucket, is not acceptable.
13. Field-cut pipe ends shall be cut square.

3.4 INSTALLATION OF DRAIN MANHOLES AND CATCH BASINS

A. The bases shall be supported on a compacted level foundation of gravel borrow a minimum of 12 inches thick. Crushed stone may be substituted for gravel borrow if field conditions at the bottom of the excavation are wet.

1. The Contractor shall install the manholes and catch basins as soon as the pipe laying reaches the location of the structures.
2. The Contractor shall accurately locate each manhole and catch basin and set accurate templates to conform to the required line and grade. Any manhole or catch basin which is not installed in the correct location or oriented improperly shall be removed and rebuilt in its proper location, alignment, and orientation at no additional cost to the Owner.
3. Manhole risers and tops shall be installed using approved butyl rubber sealant or rubber gasket for sealing joints of manhole risers and tops; jointing shall be performed in accordance with the manufacturer's recommendations. Manhole risers and tops shall be installed level and plumb. Water shall not be permitted to rise over newly made joints, nor until after inspection as to their acceptability. All jointing shall be done in a manner to ensure watertight joints.
4. Openings shall be provided in the precast concrete manhole sections to receive entering pipes and these openings shall be made at the place of manufacture. Pipe entrances at catch basins shall have plain beveled openings to accept the type of pipe specified and to be sealed with non-shrink grout. Grout mixture shall follow instructions provided by manufacturer. Pipe connections at drain manholes shall be made as indicated on the Drawings with either non-shrink grout or integral flexible rubber sleeves and Corrugated Pipe Adapters designed for use with the pipe and sleeves. For grouted joints, surface between pipe and wall shall be completely filled with non-shrink grout and troweled to provide a smooth surface conforming to both the outside and inside structure wall.
5. Care shall be taken to ensure that the openings are made to permit setting of the entering pipe at its correct elevation as indicated or directed. Manhole risers and tops shall be installed so that the manhole steps shall be in alignment.
6. All holes used for handling shall be thoroughly plugged with non-shrink grout.
7. Cutting or tampering in the field, for purpose of creating new sidewall openings or altering existing openings, will not be permitted except at the discretion of the Engineer or if necessary concrete block manhole(s) shall be used.
8. All interior manhole joints where the sealing material is not flush with the inside wall shall be grouted with non-shrink mortar and finished by hand/wet-brush.
9. A cast-in-place concrete invert shelf and channel shall be poured and shaped to the lower half of the pipes
10. Clean all debris, mortar, and soil from the bottom of all structures prior to final acceptance of the project.

3.5 SETTING MANHOLE FRAMES AND COVERS AND CATCH BASIN FRAMES AND GRATES

A. Manhole and catch basin frames shall be set with tops conforming accurately to the grade of the pavement or finished ground surface or as indicated on the Contract Drawings or as directed.

B. Brick shall be used to bring the frames to the required elevation.

1. Frames shall be set centered with the opening in the top of the precast structure on two to four courses of brick in a full bed of mortar. A thick ring of mortar extending to the outer edge of brick or concrete shall be placed all around the bottom flange of the cast iron frame. The mortar shall be smoothly finished to a height of 5 inches above the flange for 8-inch frames and sloped to shed water away from the frame.

2. Completed brick installation shall be coated with mortar at least a ¾ inch thick on the outside to provide a fully sealed and watertight collar between the top manhole section and the cover frame.
3. Only clean bricks shall be used in brick work to adjust frame elevations. The brick shall be moistened by suitable means.

C. Manhole covers shall be left in place in the frame until completion of other work at the manholes.

D. Where directed, the castings shall be temporarily set at such grades as to provide drainage during construction. The castings of structures located within the pavement area shall not be completely set to the established grade until the bottom course of pavement has been laid. The final setting of all other casting shall be performed at the proper stage of construction.

3.6 CHANGE IN TYPE

A. When an existing catch basin is to be converted to a manhole, the frame and grate shall be carefully removed and a new frame and cover installed to finish grade. If in the opinion of the Engineer the existing casting is reusable, it may be reused in the work, otherwise, it shall be disposed of off-site.
1. The sump of the catch basin shall be thoroughly cleaned of debris and silt and the interior surfaces brushed to remove contaminants.
2. The sump shall be thoroughly filled with compacted gravel to a level no greater than 6 inches below the pipe invert. A cast-in-place concrete invert shelf and channel shall be poured and shaped to the lower half of the pipes.
3. New openings in existing structures shall be carefully cut with power saws of the proper size and elevation to accept the new connection. Damage to the structure caused by the Contractor's construction methods shall be repaired at no additional cost.

3.7 STRUCTURE REBUILT

A. When in the opinion of the Engineer existing masonry structure walls show deterioration, the structure shall be rebuilt. The casting and deteriorated masonry shall be removed in a careful and neat manner until only a sound condition remains. Concrete blocks shall be used to rebuild the structure. The new masonry construction, replacing of the casting, and other incidental work shall be performed as specified above.
1. The Contractor's base bid shall include rebuilding [ ] vertical linear feet of existing manhole or catch basin structures.

3.8 AREA DRAINS

A. Install area drains per manufacturer specifications.

B. The specified PVC surface drainage inlet shall be installed using conventional flexible pipe backfill materials and procedures. The backfill material shall be crushed stone or other granular material meeting the requirements of class 2 material as defined in ASTM D2321. Bedding and backfill for surface drainage inlets shall be placed and compacted uniformly in accordance with ASTM D2321. The drain basin body will be cut at the time of the final grade. No brick, stone or concrete block will be required to set the grate to the final grade height.

C. For H-20 load rated installations, a concrete ring shall be poured under and around the grate and frame as indicated on the Drawings.

3.9 INLINE DRAINS

A. The specified PVC surface drainage inlet shall be installed using conventional flexible pipe backfill materials and procedures. The backfill material shall be crushed stone or other granular material meeting the requirements of class 1 or class 2 material as defined in ASTM D2321. Bedding and backfill for surface drainage inlets shall be well placed and compacted uniformly in accordance with ASTM D2321. The drain basin body will be cut at the time of the final grade. No brick stone or concrete block will be required to set the grate to the final grade height. For H-20 load rated installations, a concrete ring will be poured under and around the grate and frame. The concrete slab must be designed taking into consideration local soil conditions, traffic loading, and other applicable design factors. For other installation considerations such as migration of fines, ground water, and soft foundations refer to ASTM D2321 guidelines.

3.10 DRAIN COUPLINGS

A. Couplings which are factory manufactured shall be installed at all connections from existing pipe to proposed pipe unless the existing pipe is the same material as the proposed pipe and the bell and spigot end of the pipes to be connected are compatible and free from defects. All drain couplings shall be installed in accordance with the manufacturer's recommendations for the types of pipe to be connected.

3.11 CLEANOUTS

A. Install cleanouts and extensions from drain pipe to cleanout at grade as indicated on the Contract Drawings. Set cleanout frame and cover in concrete 18 by 18 by 6-inches deep, except where location is in bituminous or concrete paving. Set top of cleanout 1-inch above surrounding earth grade or flush with grade when installed in paving.

3.12 TAP CONNECTIONS

A. Make connections to existing underground drainage structures, so that finished work will conform as nearly as practicable to requirements specified for new work. The contractor shall verify the location, size, invert, and type of existing pipes at all points of connection prior to make the connections.

B. Make branch connections from side into existing piping by installing a wye or T-wyes, and couplings manufactured for use with the same type of pipe as indicated on the Contract Drawings. The Contractor shall install a 45-degree wye branch or 90-degree tee fittings in the drain pipe at all locations where storm service pipe connections are shown on the Drawings. Connections of the storm service pipes shall be made into the wye branches or tees by means of 45-degree bends. The connections shall be made thoroughly watertight and concrete shall be placed under each connection to bear on undisturbed earth and firmly support the connection.

C. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris, concrete, or other extraneous material that may accumulate.

D. Connections into existing drainage facilities shall be performed in accordance with the requirements of the City of Worcester. The Contractor shall comply with all such requirements, including securing of all required permits and paying the costs thereof.

3.13 BACKFILLING

A. General: Conduct excavation and backfill operations for structure and pipe installations in accordance with Section 312000 – EARTH MOVING/Section 312300 – EXCAVATION & FILL FOR UTILITIES AND PAVEMENT, local requirements, and the contract documents.

B. Initial backfill shall be placed evenly on both sides of the pipe to distribute the load and not to cause movement or deflection of the pipe.

3.14 INSTALLATION OF IDENTIFICATION

A. Install continuous plastic underground warning tape during back-filling of trench for underground storm drainage system piping. Locate tape two-feet below finished grade, directly over piping.

3.15 FIELD TESTING OF CORRUGATED POLYETHYLENE PIPING

A. The pipe shall be cleaned and visually inspected for offsets and obstructions prior to testing.

B. The total length of each pipe installed on the project shall be tested or inspected for deflection. Conveyance pipes connecting at both ends to concrete drainage structures (catch basins, manholes, outlet control structures, water quality structures, etc.) shall be mandrel tested. Deflection of pipes used for stormwater detention/retention/infiltration systems, and pipes connecting to wye connections, building connections, trench drains, and other connections that do not allow mandrel testing shall be verified by visual inspection by the Owner's Representative during installation.

C. Mandrel tests shall be performed by the Contractor and observed by the Owner's Representative not sooner than 20 days after completion of installation and compaction of backfill. Testing for pipes greater than 24-inch in diameter shall be tested prior to the installation of drainage structure cone and frame.

D. Installed pipe shall be tested to ensure that the maximum deflection of the pipe does not exceed 7.5 percent of its base inside diameter. The base inside diameter is defined as the specified nominal diameter minus the allowable inside diameter tolerance of 1.5% but not more than 1/2 inch.

E. A mandrel shall be pulled through the pipe by hand to ensure that maximum allowable deflections have not been exceeded. The mandrel diameter shall be verified and approved by the Owner's Representative prior to use. Use of an unapproved mandrel will invalidate the test. If the mandrel fails to pass through the pipe, the pipe will be deemed to be over-deflected.

F. The mandrel shall be a rigid device, with an odd number of legs (9 legs minimum) having an effective length not less than its nominal diameter. The mandrel shall be fabricated of steel with pulling rings at each end.

G. The minimum diameters at any point along the full length are as follows:

Nominal Size	**Minimum Mandrel Diameter**
6”	5.3”
8”	7.0”
10”	8.8”
12”	10.6”
15”	13.2”
18”	15.8”

24”	21.1”
30”	26.4”
36”	31.7”
42”	37.0”
48”	42.2”
54”	47.5”
60”	52.8”

3.16 FIELD QUALITY CONTROL

A. Testing: Perform testing of completed piping in accordance with local authorities having jurisdiction.

B. Video Inspections: Seven days after the completion of the backfilling of each section of new pipe, as defined as a length of pipe between two manholes, the Contractor will provide a televised inspection of the pipe to be submitted to the Designer. The Owner’s Representative shall be present during the recording. The recording shall be in DVD color format with audio and will show a clear picture of the inside of the new pipe. If the Designer determines that the DVD is unacceptable for review the contractor shall re-televise the line until an acceptable DVD has been submitted. In the event that the pipe is not acceptable for any reason relating to the proper construction of the pipe according to these specifications, the Contractor will be responsible to re-excavate and repair the defects to the satisfaction of the Designer at no additional cost.

C. Cleaning: Clear interior of piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.

1. In large, accessible piping, brushes and brooms may be used for cleaning.
2. Place watertight plugs in ends of uncompleted pipe at end of day or whenever work stops. If water is in the trench when work is resumed, the plug shall not be removed until the trench has been dewatered and all danger of water entering the pipe eliminated.
3. Flush piping between manholes to remove collected debris.

D. Interior Inspection: If deemed necessary by the Owner’s Representative, inspect piping to determine whether line displacement or other damage has occurred.

1. Make inspections after pipe between manholes has been installed and approximately 2 feet of backfill is in place, and again at completion of project.
2. If inspection indicates poor alignment, debris, displaced pipe, infiltration or other defects, the Contractor shall correct such defects and reinspect.

E. Prior to acceptance of the storm drainage system, the Contractor shall submit the following to the Architect and to the local authority:

1. System As-Built Plan stamped by a Professional Land Surveyor or Engineer Registered in the Commonwealth of Massachusetts.
2. Video inspection DVDs and report: The report shall document the observations of the video inspections.
3. Deflection test report: The report shall fully describe the test procedures and list the test results. The report shall be signed by the Contractor’s superintendent.

3.17 FINAL INSPECTION

A. Final inspection and acceptance of the storm drainage system shall be made by the Owner's Representative and the utility owner having jurisdiction of the particular system.

B. Prior to placing the systems in service, all components shall be inspected, with the Owner's Representative present, to ensure that no debris or other contaminants are present. If necessary, the Contractor shall clean the structures and flush piping.

C. The Contractor is responsible for coordinating and scheduling the inspection of the work by local jurisdictional authorities. No additional payment will be made for inspections and permits required in the performance of the work.

END OF SECTION

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APPENDIX A – CITY OF WORCESTER CONSERVATION COMMISSION ORDER OF CONDITIONS

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Not Used

City of Worcester, Massachusetts
Conservation Commission
Order of Conditions

Conservation Commission File Number:

CC-2023-028

City of Worcester Wetlands Protection Ordinance & Wetlands Protection Regulations - September, 1990; as amended (City's General Revised Ordinance Part I, Chapter 6)

A. General Information

1. From:

City of Worcester
Conservation Commission

2. This issuance is for (check one): ☒ Order of Conditions ☐ Amended Order of Conditions

3. To: Applicant:

a. First Name | b. Last Name

City of Worcester Department of Public Works & Parks
c. Organization

50 Officer Manny Familia Way
d. Mailing Address

Worcester | MA | 01605
e. City/Town | f. State | g. Zip Code

4. Property Owner (if different from applicant):

a. First Name | b. Last Name

c. Organization

d. Mailing Address

e. City/Town | f. State | g. Zip Code

5. Project Location:

69 Sever Street | Worcester
a. Street Address | b. City/Town

02-041 | -49+98
c. Assessors Map/Plat Number | d. Parcel/Lot Number

Latitude and Longitude, if known: d. Latitude | e. Longitude

6. Project Description: To construct park improvements, including a retaining wall, picnic area, benches, walkways, landscaping, drainage improvements, and related site work.

7. Conservation Commission Review Trigger: The activities shall occur within the Stormwater Protection Zone.

8. Property recorded at the Registry of Deeds for (attach additional information if more than one parcel):

a. County	b. Certificate Number (if registered land)
Worcester	
c. Book	**d. Page**
66353	346

9. Dates:

a. Date Notice of Intent Filed	b. Date Public Hearing Closed	c. Date of Issuance
4/12/2023	5/22/2023	6/5/2023

10. Final Approved Plans and Other Documents (attach additional plan or document references as needed):

Sever Street Park	
a. Plan Title	
RDLA / Nitsch Engineering	Christopher Dean Hodney, P.E.
b. Prepared By	c. Signed and Stamped by
4/12/2023	1”=20’
d. Final Revision Date	e. Scale

f. Additional Plan or Document Title	g. Date
NOI Application Materials	4/12/2023
Stormwater Report	4/12/2023

B. Findings

11. Findings pursuant to the City of Worcester Wetlands Protection Ordinance:

Following the review of the above-referenced Notice of Intent and based on the information provided in this application and presented at the public hearing, this Commission finds that the areas in which work is proposed is significant to the following interests of the Wetlands Protection Ordinance. Check all that apply:

☒ Public Water Supply	☒ Erosion and Sedimentation Control	☒ Prevention of Pollution
☒ Private Water Supply	☒ Fisheries	☒ Protection of Wildlife Habitat
☒ Groundwater Supply	☒ Storm Damage Prevention	☒ Flood Control

12. This Commission hereby finds the project, as proposed, is: (check one of the following boxes)

Approved subject to:

☒ the following conditions which are necessary in accordance with the performance standards set forth in the wetlands regulations. This Commission orders that all work shall be performed in accordance with the Notice of Intent referenced above, the following General Conditions, and any other special conditions attached to this Order. To the extent that the following conditions modify or differ from the plans, specifications, or other proposals submitted with the Notice of Intent, these conditions shall control.

B. Findings (cont.)

Denied because:

☐ The proposed work cannot be conditioned to meet the performance standards set forth in the wetland regulations. Therefore, work on this project may not go forward unless and until a new Notice of Intent is submitted which provides measures which are adequate to protect the interests of the Ordinance, and a final Order of Conditions is issued. **A description of the performance standards which the proposed work cannot meet is attached to this Order.**

☐ The information submitted by the applicant is not sufficient to describe the site, the work, or the effect of the work on the interests identified in the Wetlands Protection Act. Therefore, work on this project may not go forward unless and until a revised Notice of Intent is submitted which provides sufficient information and includes measures which are adequate to protect the Ordinance's interests, and a final Order of Conditions is issued. **A description of the specific information which is lacking and why it is necessary is attached to this Order.**

C. General Conditions Under Wetlands Protection Ordinance

The following conditions are only applicable to Approved projects.

1. Failure to comply with all conditions stated herein, and with all related statutes and other regulatory measures, shall be deemed cause to revoke or modify this Order.

2. The Order does not grant any property rights or any exclusive privileges; it does not authorize any injury to private property or invasion of private rights.

3. This Order does not relieve the permittee or any other person of the necessity of complying with all other applicable federal, state, or local statutes, ordinances, bylaws, or regulations.

4. The work authorized hereunder shall be completed within three years from the date of this Order unless either of the following apply:
   a. the work is a maintenance dredging project as provided for in the Act; or
   b. the time for completion has been extended to a specified date more than three years, but less than five years, from the date of issuance. If this Order is intended to be valid for more than three years, the extension date and the special circumstances warranting the extended time period are set forth as a special condition in this Order.

5. This Order may be extended by the issuing authority for one or more periods of up to three years each upon application to the issuing authority at least 30 days prior to the expiration date of the Order.
6. If this Order constitutes an Amended Order of Conditions, this Amended Order of Conditions does not extend the issuance date of the original Final Order of Conditions and the Order will expire on _____ unless extended in writing by the Department.

7. Any fill used in connection with this project shall be clean fill. Any fill shall contain no trash, refuse, rubbish, or debris, including but not limited to lumber, bricks, plaster, wire, lath, paper, cardboard, pipe, tires, ashes, refrigerators, motor vehicles, or parts of any of the foregoing.

8. This Order is not final until all administrative appeal periods from this Order have elapsed, or if such an appeal has been taken, until all proceedings before the Department have been completed.

9. No work shall be undertaken until the Order has become final and then has been recorded in the Registry of Deeds for the district in which the land is located, within the chain of title of the affected property. In the case of recorded land, the Final Order shall also be noted in the Registry's Grantor Index under the name of the owner of the land upon which the proposed work is to be done. In the case of the registered land, the Final Order shall also be noted on the Land Court Certificate of Title of the owner of the land upon which the proposed work is done. The recording information shall be submitted to the Conservation Commission on the form at the end of this Order, which form must be stamped by the Registry of Deeds, prior to the commencement of work.

10. A sign shall be displayed at the site not less then two square feet or more than three square feet in size bearing the words "City of Worcester Conservation Commission File Number **CC-2023-028**."

11. Within thirty (30) days of completion of the work described herein, the applicant shall submit a Request for Certificate of Compliance to the Conservation Commission.

12. The work shall conform to the plans and special conditions referenced in this order.

13. Any change to the plans identified in Condition #12 above shall require the applicant to inquire of the Conservation Commission in writing whether the change is significant enough to require the filing of a new Notice of Intent.

14. The Agent or members of the Conservation Commission shall have the right to enter and inspect the area subject to this Order at reasonable hours to evaluate compliance with the conditions stated in this Order, and may require the submittal of any data deemed necessary by the Conservation Commission or Department for that evaluation.

15. This Order of Conditions shall apply to any successor in interest or successor in control of the property subject to this Order and to any contractor or other person performing work conditioned by this Order.

16. All sedimentation barriers shall be maintained in good repair until all disturbed areas have been fully stabilized with vegetation or other means. At no time shall sediments be deposited in a wetland or water body. During construction, the applicant or his/her designee shall inspect the erosion controls on a daily basis and shall remove accumulated sediments as needed. The applicant shall immediately control any erosion problems that occur at the site and shall also immediately notify the Conservation Commission, which reserves the right to require additional erosion and/or damage prevention controls it may deem necessary. Sedimentation barriers shall serve as the limit of work unless another limit of work line has been approved by this Order.

17. The Commission orders that all work shall be performed in accordance with the following conditions and with the Notice of Intent referenced above. To the extent that the following conditions modify or differ from the plans, specifications, or other proposals submitted with the Notice of Intent, the conditions shall control.

18. The special conditions relating to municipal ordinance or bylaw are as follows (if you need more space for additional conditions, attach a text document): **See Attachment A.**

ATTACHMENT A

Worcester Conservation Commission

Special Order of Conditions

City of Worcester Wetlands Protection Ordinance & City of Worcester Wetlands Protection Regulations

(City of Worcester Revised Ordinance Part I, Chapter 6)

69 Sever Street (CC-2023-028)

Project Description: To construct park improvements, including a retaining wall, picnic area, benches, walkways, landscaping, drainage improvements, and related site work.

Findings/Waivers: n/a

Table of Contents:

Notes:

- **Office of the Commission** is located at the Division of Planning and Regulatory Services (455 Main Street 4th floor, Worcester, MA), which can be contacted by e-mailing planning@worcesterma.gov or calling 508-799-1400 ext. 31440.
- **Asterisked (*) conditions** are standard conditions of approval for all projects.

I. Conditions to Meet Prior to and During Construction

21. Person Responsible for Compliance with the Order of Conditions* – A person shall be designated to be responsible to monitor compliance with the Order of Conditions. Their name and contact information (24/7) shall be provided to the Office of the Commission prior to start of any activity. This person shall conduct:
    a) periodic inspections to assure the adequacy and continued effectiveness of erosion and sediment controls;
    b) inspections of said controls following 0.5-inch or greater rain events, or after a heavy snow melt.
22. Contract* - This Order of Conditions and all approved plans shall be included as part of any contract and subcontract and shall be posted in a prominently displayed location in the supervisory office on site during all phases of construction.
23. Notification* - The applicant shall notify the Office of the Commission a minimum of 48 hours prior to the start of any activity.

II. Conditions to Meet Before the Start of Any Activity

24. Stormwater Management System Maintenance – Prior to the start of any activity, the applicant must submit in writing the name, address and telephone number of the party responsible for ongoing maintenance of the stormwater management system components.
25. Stormwater Pollution Prevention Plan (SWPPP)* – That one (1) digital copy of the SWPPP submitted to the EPA in compliance with the NPDES permit requirements, if applicable, shall be provided to the Office of the Commission prior to commencement of work. The contact information for the SWPPP inspector as well as evidence of their status as a Qualified Person to conduct inspections under Part 4 of the Construction General Permit (i.e. a certificate of completion of the NPDES Construction Inspection Training Course) shall also be provided.
26. Pre-Construction Conference* -
    a) The Conservation Commission or its Agents shall conduct a pre-construction conference prior to commencement of activities in each phase of the project. Phasing, if any, shall conform to the approved plans.
    b) The property owner / applicant and any person performing work that is subject to this Order are responsible for understanding and complying with the requirements of this Order, the Wetlands Protection Act, 310 CMR 10.00 and City of Worcester Wetlands Protection Ordinance and Regulations. Said persons shall acknowledge such in writing prior to commencement of activities.
27. Inspections Prior to Site Preparation and Site Work* - Erosion and sediment controls shall be installed and verified, in compliance with final approved plans, by the Commission or its Agents prior to the commencement of any excavation, grubbing and/or stumping of vegetation, grading, construction, or other site preparation.
28. Construction Schedule* - Submit a Construction Schedule consistent with Work Sequencing plans provided to the Office of the Commission prior to the start of any activities.

III. Stormwater Management System

29. Catch Basins* –
    a) The paved roadways and parking lots shall be bermed and shall be installed with standard City of Worcester catch basins.
    b) Prior to start of activity on site that causes soil erosion and sedimentation, catch basin filter traps shall be installed in the existing and new catch basins.

c) Catch basins shall be cleaned as warranted during construction to keep them clear of sediment, and minimum twice a year thereafter.

30. Stormwater Management System Maintenance* – The stormwater management system shall be maintained in accordance with the approved design plans and Operation and Maintenance Plan on file with the Office of the Commission. The system shall be maintained in good hydraulic condition (e.g. any accumulated silt/sediment shall be removed; the system shall be kept free of any litter, refuse, or other extraneous matter, etc.). **This condition shall extend in perpetuity beyond the issuance of the Certificate of Compliance**.

IV. Conditions to Meet During Construction

31. Limit of Work* – No removal, filling, dredging or altering of jurisdictional areas shall take place outside the approved work under this Order of Condition.

32. Work Sequencing* – Activities shall take place in accordance with all phasing and sequencing shown on the plan and/or provided in the application materials on file with the Office of the Commission and shall follow any lot opening restrictions otherwise provided herein.

33. Erosion Stabilization -

a) *Erosion and Sediment Controls** - All erosion and sediment controls shall be monitored, maintained, and adjusted for the duration of the project to prevent adverse impacts to jurisdictional areas. Additional erosion and sediment controls may be utilized on site as needed.

b) *Off Site Impacts** - There shall be no off-site erosion, flooding, ponding, or flood-related damage from runoff caused by the project activities.

c) *Unanticipated Drainage or Erosion** - The applicant shall control any unanticipated drainage and/or erosion conditions that may cause damage to jurisdictional areas and/or abutting or downstream properties. Said control measures shall be implemented immediately upon need. The Office of the Conservation Commission shall be notified if such conditions arise and of the measures utilized.

d) *Soil Stabilization due to Delay in Work** - If there is an interruption of more than 10, but less than 60 days between completion of grading and revegetation, the applicant shall sow all disturbed areas with annual rye grass to prevent erosion. If soils are to be exposed for longer than 60 days, a temporary cover of rye or other grass should be established following US Soil Conservation Services procedures, as recently amended, to prevent erosion and sedimentation. Once final grading is complete, loaming and seeding of final cover should be completed promptly.

e) *Grading of Slopes**-

i. >40% Slope – Slopes shall not exceed those specified in the plans approved by the Conservation Commission. Any slope equal to or greater than 40% (1 vertical to 2 1/2 horizontal) shall be stabilized with erosion control matting.

ii. <40% Slope – Final grades of vegetated areas shall not exceed a slope of 1 vertical to 2 1/2 horizontal (40%) and shall be stabilized to prevent erosion, particularly during the construction period.

f) *Stockpile Maintenance** - Any stockpiling of loose materials shall be properly stabilized to prevent erosion into and sedimentation of jurisdictional areas. Preventative controls such as strawbales or erosion control matting shall be implemented to prevent such an occurrence.

g) *Stockpile Location* – In no case shall any soil or excavated material be stockpiled within 50 feet of any wetland, floodplain, or storm drain inlet.

h) *Site Stabilization Prior to Winter** - Prior to winter, exposed soils shall be stabilized (e.g. with demonstrated vegetative growth, impermeable barriers, erosion control blankets, etc.).

34. Invasive Insects* -

    a) *Plantings* – No trees to be planted shall be species susceptible to the Asian Longhorned Beetle or Emerald Ash Borer.

    b) *Wood Removal* – All tree, brush & wood removal shall adhere to the most recently amended requirements set forth by the Massachusetts Department of Conservation & Recreation for any project located in the Asian Longhorned Beetle Quarantine Zone.

35. Invasive Vegetation – The goal of this condition is to keep jurisdictional areas (bufferzone and resource areas) free of all invasive, likely invasive, and potentially invasive species as identified in *The Evaluation of Non-native Plant Species for Invasiveness in Massachusetts,* published by the MA Invasive Plant Advisory Group in April 1, 2005. This condition is intended to prevent the introduction and spread of non-native and invasive species which are known to result in resource area alterations and have impacts on wildlife habitat, etc.

    a) *Material Introduction* – All imported materials, such as compost, topsoil, etc. shall be inspected for evidence of invasive vegetation prior to use within jurisdictional areas at the site in order to prevent introduction and/or the spread of invasive vegetation. No materials with evidence of invasive vegetation shall be used in jurisdictional areas.

    b) *On-going Management* - A weeding program must be implemented within all jurisdictional areas that are disturbed as part of the project. The weeding program shall begin within one month of when final grades are reached and shall continue, at a minimum of, twice per growing season until a Certificate of Compliance is issued for the project.

36. Dust Control* - Provisions for dust control shall be provided during all construction and demolition activities. Such provisions shall be conducted in compliance with all City of Worcester Water Use Restrictions, if in effect, during such activities.

37. Dewatering* – If dewatering is required,

    a) Notice of such activities shall be given to the Office of the Commission within 24 hours of commencement;

    b) There shall be no discharge of untreated dewatered stormwater or groundwater to jurisdictional areas either by direct or indirect discharge to existing drainage systems;

    c) Any discharge to surface waters or drainage structures must be visibly free of sediment;

    d) To the maximum extent practicable, proposed dewatering activities should be located outside of the 100’ buffer. If such activities must be located within the 100’ buffer, they shall be monitored at all times when the pumps are running;

    e) Dewatering activities shall be confined within an area of secondary containment at all times.

38. SWPPP Monitoring Construction Reports – Written construction reports or copy of SWPPP reports, shall be submitted to the Office of the Commission during all earthwork and drainage construction. Reports shall be submitted monthly or after each precipitation event (rain or snow melt) of 0.5 inches or greater, whichever is more frequent, and shall include:

    a) an evaluation, during such events, of all existing erosion and sedimentation controls, as well as stormwater management system/s performance; and

    b) solutions employed and/or recommendations to fix areas found to be deficient, if any.

39. Spill Prevention* -

    a) No fuel, oil, or other pollutants shall be stored in any resource area or the buffer zone thereto, unless specified in this Order;

b) No refueling shall take place within resource areas or 100-ft to a resource area;

c) The applicant shall take all necessary precautions to prevent discharge or spillage of fuel, oil or other pollutants onto any part of the site;

d) A spill kit shall be present on site at all times.

V. Conditions to Meet at Completion of Project

40. Site Stabilization* - All disturbed areas shall be properly stabilized with well-established perennial vegetation or other approved methods before the project is considered complete.

41. Erosion and Sediment Controls* - Erosion and sediment controls shall not be removed from the site until all disturbed areas have been stabilized with final vegetative cover and approval has been received from the Commission or its Agents to do so. The controls must then be removed within two weeks of receipt of that certification.

42. Certificate of Compliance* - Upon completion of the project, the applicant shall request in writing a Certificate of Compliance from the Commission. If the project has been completed in accordance with plans stamped by a registered professional engineer, architect, landscape architect, or land surveyor, certification must include a written statement by such professional certifying the same.

    a) If the project required compliance with the Massachusetts Stormwater Standards and/or work was conducted within Riverfront Area or Bordering Land Subject to Flooding, a certified as-built plan-of-land shall be provided showing final grades, resource areas, and all constructed improvements;

    b) If permanent markers were required, the certified as-built plan-of-land shall depict their location.

43. Sand/Salt – The use of sand and salt on paved surfaces shall be kept to an absolute minimum during the winter months.

44. Deed Condition – Conditions numbered 30 & 43 shall extend beyond the Certificate of Compliance, in perpetuity, and shall be referred to in all future deeds to this property.

VI. General Conditions

45. Change in Ownership* - If a change in ownership takes place while this Order is still in effect, it is the responsibility of the new owner to notify the Commission of the change and to provide the name of the person responsible for compliance with the Order.

46. Conservation Agent's Power to Act* - With respect to all conditions, except _____, the Conservation Commission designates the Conservation Agent, as its Agent with full powers to act on its behalf in administering and enforcing this Order, unless the Agent determines approval from the Commission is appropriate.

47. Right to Inspect* - A member of the Conservation Commission or its Agent may enter and inspect the property and the activity that are the subjects of this Order at all reasonable times, with or without probable cause or prior notice, and until a Certificate of Compliance is issued, for the purpose of evaluating compliance with this Order (and other applicable laws and regulations).

48. Changes to the Plan or Errors & Omissions* -

    (a) If any plan, calculation, or other data presented to the Office of the Commission is in error or have omissions, and are deemed significant by the Commissioners or their Agents, all work will stop at the discretion of the Commission, until the discrepancies have been rectified to the Commission's satisfaction.

    (b) The applicant must notify the Commission in writing of any changes in the plans or implementation of the proposed activity where mandated by any local, state, or federal agencies having jurisdiction over the proposed activity. If, in the opinion of the Commission,

any changes in the plans or implementation of the proposed activity so require, then the Commission may modify, amend or rescind this Order in a way consistent with:

- M.G.L. Chapter 131, Section 40,
- 310 CMR 10.00, *Wetlands Protection*,
- the City of Worcester's *Wetlands Protection Ordinance*, and
- the Commission's *Wetlands Protection Regulations*

If any provisions of any conditions, or application thereof is held to be invalid, such invalidity shall not affect any other provisions of this Order. If the Commission deems that a proposed change is major or substantial, a new hearing may be required.

49. Liability* - The applicant shall indemnify and save harmless the Commonwealth, the City of Worcester, the Conservation Commission, and its Agents against all sites, claims or liabilities of every name and nature arising at any time out of or in consequence of the acts of the Commission or its Agents in the performance of the work covered by this Order and/or failure to comply with the terms and conditions or this Order whether by itself or its employees or subcontractors.

C. Signatures

This Order is valid for three years, unless otherwise specified as a special condition pursuant to General Conditions #4, from the date of issuance.

6/5/2023
1. Date of Issuance

Please indicate the number of members who will sign this form.
This Order must be signed by a majority of the Conservation Commission.

3 of 5
2. Number of Signers

The Order must be mailed by certified mail (return receipt requested) or hand delivered to the applicant. A copy also must be mailed or hand delivered at the same time to the property owner, if different from applicant.

The names typed below represent the intent to sign the foregoing document in accordance with MGL Chapter 110G §9

Duly authorized by Ch.110G and recorded at Worcester Registry of Deeds in Book 62537 Page 329.

Signatures:

DocuSigned by:
644D158086034CF...

DocuSigned by:
F683C367C17D49E...

DocuSigned by:
1EC379ADB20C4D0...

by hand delivery on
6/5/2023
Date

by certified mail, return receipt requested, on
Date

D. Appeals

Appeal from a decision of the Conservation Commission shall be taken in accordance with law to the Superior Court or other body of competent jurisdiction. Any such appeal shall be taken within ten (10) days from the date from the receipt of such decision and shall not relieve the individual of the responsibility of taking an appeal to Department of Environmental Protection if such is required under said regulations.

No work may proceed until the appeal on the Commission's decision on a Notice of Intent has been decided and all appeal periods have elapsed.

E. Recording Information

Prior to commencement of work, this Order of Conditions must be recorded in the Registry of Deeds for the district in which the land is located, within the chain of title of the affected property. In the case of recorded land, the Final Order shall also be noted in the Registry's Grantor Index under the name of the owner of the land subject to the Order. In the case of registered land, this Order shall also be noted on the Land Court Certificate of Title of the owner of the land subject to the Order of Conditions. The recording information on this page shall be submitted to the Conservation Commission listed below.

Conservation Commission

Detach on dotted line, have stamped by the Registry of Deeds and submit to the Conservation Commission.

To:

Conservation Commission

Please be advised that the Order of Conditions for the Project at:

Project Location | Conservation Commission File Number

Has been recorded at the Registry of Deeds of:

County | Book | Page

for: Property Owner

and has been noted in the chain of title of the affected property in:

Book | Page

In accordance with the Order of Conditions issued on:

Date

If recorded land, the instrument number identifying this transaction is:

Instrument Number

If registered land, the document number identifying this transaction is:

Document Number

Signature of Applicant

APPENDIX B – GEOTECHNICAL REPORT, OHI ENGINEERING

This Page Intentionally

Not Used

OHI Engineering, Inc.
Engineers & Environmental Scientists

44 Wood Avenue
Mansfield, MA 02048
Tel (508) 339 – 3929
Fax (508) 339 - 3140

December 15, 2022

Ray Dunetz, RLA
Ray Dunetz Landscape Architecture, Inc.
179 Green Street
Boston, MA 02130

Re: Subsurface Evaluation
Worcester Art Park
69 Sever Street
Worcester, MA 01603
OHI Project # 22-2285

Dear Mr. Dunetz:

OHI Engineering, Inc. (OHI) is pleased to submit this Preliminary Geotechnical Evaluation for the Worcester Art Park in Worcester, Massachusetts (the "Site"). The Site is located at 69 Sever Street in Worcester (see **Figure 1 – Locus**). The evaluation was conducted in accordance with our agreement.

1.0 INTRODUCTION

The Site consists of a kidney-shaped walking path, flag pole, and bathroom facilities all surrounded by a chain-link fence. The proposed work will involve the installation of several new art pieces and associated footing structures.

2.0 SUBSURFACE EVALUATION

The subsurface evaluation consisted of three GeoProbe soil borings completed at the Site at locations approved by a City of Worcester Park representative. Prior to conducting the soil borings, the Site was pre-marked and Dig-Safe was contacted for utility mark out. Also, applicable access permits were obtained from the city to accomplish the subsurface campaign.

Three soil borings were completed on Thursday, November 17, 2022. A City of Worcester representative was on-site to provide access to the park and water. The three soil borings, numbered SB-1 to SB-3, were advanced at the Site by Geologic Earth Exploration from Norfolk, MA using a truck-mounted rig.

Bedrock refusal was encountered at 19 feet bsg in SB-1. At probe locations SB-2 and SB-3, the borings were advanced to depths of 16 feet below surface grade (bsg). Refusal was not encountered in either of the other test probes. The test probe locations are shown on **Figure 2 – Site Plan**. Test probe logs are provided in **Appendix A**. All test probes were completed within the boundaries of the park as approved by the City of Worcester.

Soils at SB-1 were described as loose fill in the top four feet then medium dense to dense glacial till consisting of fine to coarse SAND and SILT with some cobbles from approximately four to sixteen feet bsg. Groundwater was observed at approximately eight feet below surface grade (bsg). Bedrock refusal was encountered at approximately 19 feet bsg.

Soils at SB-2 were similar to those in SB-1 and were described as loose fill in the top two feet then medium dense to dense, fine to medium SAND and SILT with some pebbles and cobbles from approximately four to sixteen feet bsg. Groundwater was observed at approximately nine feet bsg.

Soils at SB-3 were described as loose fill from grade to approximately two feet bgs. Loose fine sand and silt were observed between two and six feet bsg. At approximately nine feet and extending down to 16 feet bsg, medium dense, gray-blue, fine to coarse SAND and SILT with fine to medium gravel was observed. Cobbles were encountered at an approximate depth of nine to 16 feet bsg. Groundwater was observed at approximately nine feet bsg.

The natural soils are defined as loose Material Class 7, Granular Ablation Till, on Table 1806.2a of the Massachusetts Building Code. Net allowable bearing pressure of **two tons per square foot** should be used in design.

Groundwater was measured between eight and nine feet bsg. It is anticipated that the depth to groundwater will fluctuate due to season, temperature, precipitation, and construction activity in the area; therefore, water levels during and following construction will vary from those observed in the subsurface explorations.

3.0 FOUNDATION EVALUATION

Fill soils encountered in borings SB-1 through SB-3 should be removed and replaced with structural fill described below. Once the final sculpture locations are known, soil sampling is recommended as the fill material may require special handling and disposal. The undisturbed naturally deposited till soils and gravelly-sands at the Site are considered suitable for support of base supports. The subsurface soils encountered in the borings are loose to medium-dense ablation till meeting Material Class 7, Table 1806.2a of the *Massachusetts Amendments to the International Building Code 2009, Eight Edition* (Massachusetts Building Code).

3.1 Support Foundation Qualifiers

1. The Massachusetts Building Code, Table 1806.2a *Presumptive Allowable Vertical Bearing Pressures* provides a net bearing pressure of two (2) tons per square foot for Material Class 7.

2. For purposes of seismic design and in accordance with the *Massachusetts Amendments to the International Building Code 2009 (Basic/Commercial) Eighth Edition*, the profile at the project site is classified as Site Class D, with Site Coefficients F_a (short period) of 1.6 and F_v (1-second period) of 2.4. The soils are not considered susceptible to liquefaction.

The work should be done in dry conditions. Dewatering requirements will vary across the Site based on groundwater levels encountered during construction and local soil conditions. In general, it should be practicable to accomplish construction dewatering from within excavations by open pumping methods to depths of about one foot below free water levels encountered in excavations. Dewatering to greater depths below groundwater will likely require the use of deep sumps or wells. Surface runoff and infiltration of groundwater should be controlled so that excavation, construction, and backfilling can be completed in the dry.

Dense graded crushed stone for use as backfill should be a clean, well-graded sand and gravel mixture meeting the following gradation.

Dense graded crushed stone Gradation

Screen or Sieve Size	Percent Passing
3 inches	90-100
No. 4	35 - 70
No. 40	10 - 35
No. 200	0 - 10

Note: Maximum particle size limited to 3 inches.

In confined areas, structural fill should be placed in lifts not exceeding 6 inches in uncompacted thickness and compacted with hand-operated compaction equipment. Fill should be compacted to at least 95 percent of the maximum dry density as determined by ASTM D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort [56,000 ft-lbf/ft3 (2,700 kN-m/m3)].

Visual classifications of the on-Site soils from the probe logs provided indicate the on-site soils are not likely to be suitable as structural fill, but may be acceptable for use as general fill in landscaped areas, if needed. On-site soils should be segregated and stockpiled during construction. Laboratory testing will be needed to determine if the on-Site soils are suitable for use as fill, or if special handling will be required for off-Site disposal.

Since the above recommendations are based on limited numbers of observations and tests, the Owner and the project Contractor should be particularly sensitive to the potential need for adjustments in the field.

4.0 SUMMARY

The evaluations and recommendations presented in this Geotechnical Evaluation are based on the results of three subsurface boring explorations. The nature of variations between the explorations may not become evident until construction has begun. If variations are encountered, it may be necessary for OHI to re-evaluate the recommendations presented in this report.

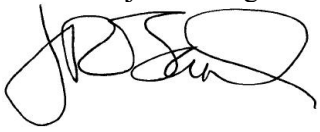
We appreciate the opportunity to work with you on this project. Please do not hesitate to contact us should you have questions or comments regarding this matter.

Very truly yours,

OHI ENGINEERING, INC.

Douglas C. Morrison
Senior Project Manager

Jared J. Kelly
Project Engineer

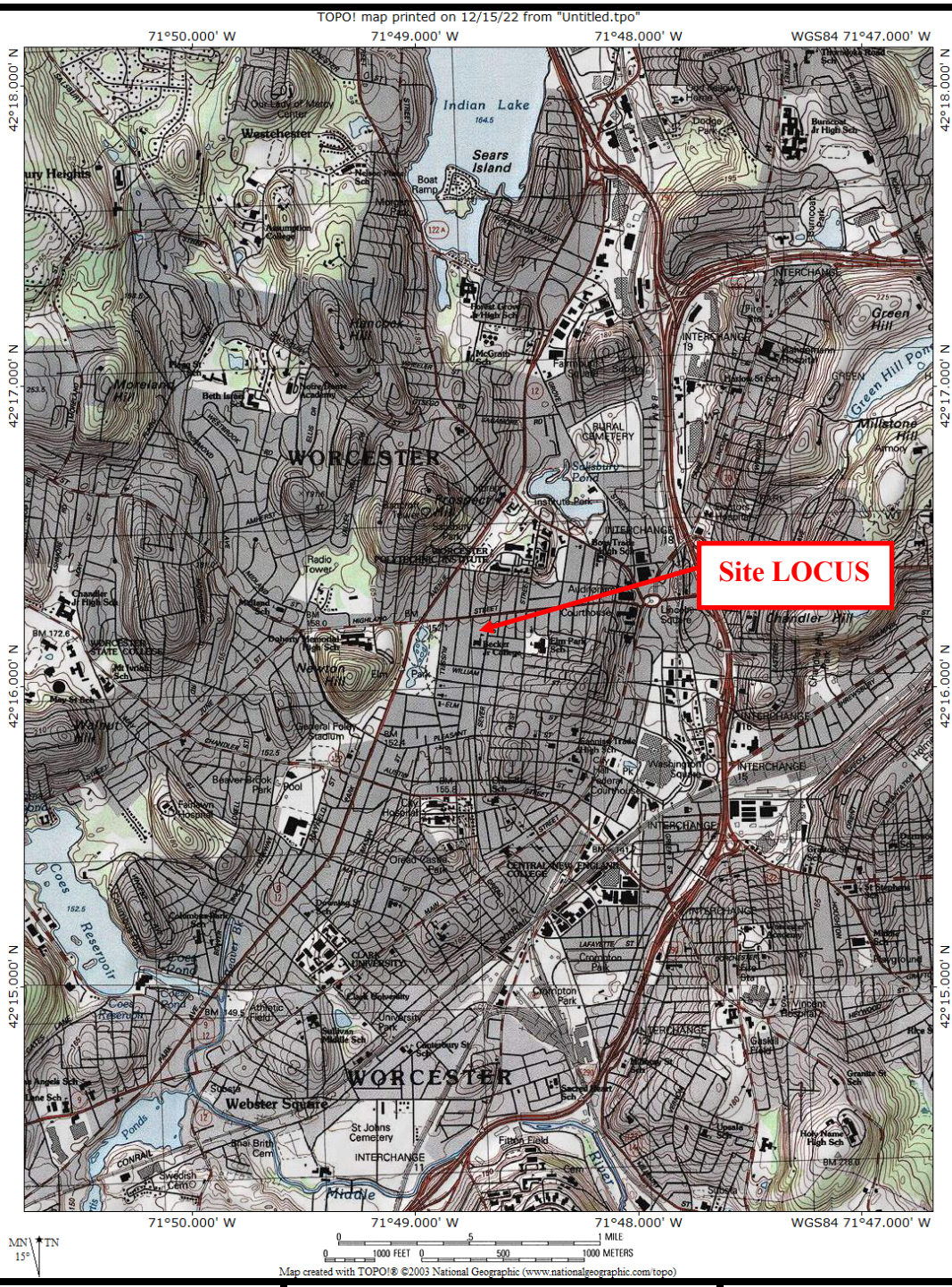


James R. Borrebach, P.E., L.S.P.
Principal

Attachments

OHI Engineering, Inc.
Engineers & Environmental Scientists

FIGURES



Site LOCUS

Figure 1

Art Park
69 Sever Street
Worcester, Massachusetts

OHI Engineering, Inc.
Engineers & Environmental Scientists

44 Wood Avenue · Mansfield, MA

N
W E
S

Site Plan – Boring Locations

Figure 2

Art Park
69 Sever Street
Worcester, Massachusetts

OHI Engineering, Inc.
Engineers & Environmental Scientists

44 Wood Avenue · Mansfield, MA

N
W E
S

OHI Engineering, Inc.
Engineers & Environmental Scientists

APPENDIX A

Boring Logs

SOIL TEST BORING LOG & MONITORING WELL COMPLETION REPORT

OHI Engineering, Inc.
Engineers & Environmental Scientists

44 Wood Avenue
Mansfield, MA 02048
Voice: (508) 339-3929
Fax: (508) 339-2893

PROJECT:	*Art Park*	**BORING:**	**SB-1**
	69 Sever Street	**WELL:**	**NA**
	Worcester, Massachusetts	**SHEET:**	**1 of 1**

CONTRACTOR:	Geologic Earth Exploration, Inc.	**SIZE:**	2"	**SAMPLER:**	**START DATE:**	11/17/2022
GEOLOGIST/ENG.:	JJK	**WEIGHT:**	140 lb	Split Spoon	**FINISH DATE:**	11/17/2022
DRILL RIG:	Truck Mounted (Drive n'Wash)	**FALL:**	30"		**SURFACE GRADE:**	N/A

DEPTH (FT)	PID (ppmv)	BLOW COUNTS 0 - 6"	6" - 12"	12" - 18"	18" - 24"	REC		DESCRIPTION	DIAGRAM
+1	N/A					%			
1		1	1	5	6	50%		Loam Tan-Grey F-M Sand/Silt w/ Trace F Gravel	
2									
3		8	6	6	14	17%		Ash and Fill Rock in Tip of Spoon	
4									
5		13	15	20	23	50%		Tan-Gray F-C SAND w/ Some Silt Dry.	
6									
7		30	32	28	24	75%		Grey-Blue TILL F-M Sand/Silt w/ Cobbles GW @ ~ 8' bgs	
8									
9		18	20	21	23	50%		Same as Above	
10									
11		30	26	66	30	83%		Same as Above w/ Some Cobbles	
12									
13									
14									
15		21	19	19	17	33%		Same as Above	
16									
17									
18									
19									
20		100/1"	---	---	---	0%		Roller Bit Refusal at ~ 19' bgs	
21									
22								End of Exploration @ ~ 19' bgs	
23									
24									
25									
26									
27									

Penetration Resistance

Cohesionless Density		Cohesive Consistency	
0 - 4	very loose	0 - 2	very soft
5 - 9	loose	3 - 4	soft
10 - 29	med. dense	5 - 8	med. stiff
30 - 49	dense	9 - 15	stiff
50+	very dense	16 - 30	very stiff
		31+	hard

Terms

Proportion Definition	
trace	0% - 10%
little	10% - 20%
some	20% - 35%
and	35% - 50%

Groundwater Observations

@ _____ ft.

@ _____ ft. after _____ hours

SOIL TEST BORING LOG & MONITORING WELL COMPLETION REPORT

OHI Engineering, Inc.
Engineers & Environmental Scientists

44 Wood Avenue
Mansfield, MA 02048
Voice: (508) 339-3929
Fax: (508) 339-2893

PROJECT:	*Art Park*	**BORING:**	**SB-2**
	69 Sever Street	**WELL:**	**NA**
	Worcester, Massachusetts	**SHEET:**	**1 of 1**

CONTRACTOR:	Geologic Earth Exploration, Inc.	**SIZE:**	2"	**SAMPLER:**	**START DATE:**	11/17/2022
GEOLOGIST/ENG.:	JJK	**WEIGHT:**	140 lb	Split Spoon	**FINISH DATE:**	11/17/2022
DRILL RIG:	Truck Mounted (Drive n'Wash)	**FALL:**	30"		**SURFACE GRADE:**	N/A

DEPTH (FT)	PID (ppmv)	BLOW COUNTS 0 - 6"	6" - 12"	12" - 18"	18" - 24"	REC		DESCRIPTION	DIAGRAM
+1	N/A					%			
1		1	2	6	7	50%		Loam Pink-Gray Fill (Brick and Ash)	
2									
3		7	6	4	4	67%		Tan-Gray F-M SAND/SILT w/ Some Pebbles	
4									
5		6	11	14	13	58%		Tan-Gray F-M SAND/SILT Moist	
6									
7		11	24	26	30	75%		Tan-Gray F-M SAND/SILT Glacial Till Grey F-C Sand/ Silt w/ Pebbles	
8									
9									
10		20	32	38	30	54%		Wet. Gray F-C SAND/SILT w/ Pebbles and Cobbles GW @ ~ 9' bgs	
11									
12									
13									
14									
15		18	15	20	20	50%		Same as Above	
16									
17								End of Exploration @ ~ 16' bgs	
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									

Penetration Resistance

Cohesionless Density		Cohesive Consistency	
0 - 4	very loose	0 - 2	very soft
5 - 9	loose	3 - 4	soft
10 - 29	med. dense	5 - 8	med. stiff
30 - 49	dense	9 - 15	stiff
50+	very dense	16 - 30	very stiff
		31+	hard

Terms

Proportion Definition	
trace	0% - 10%
little	10% - 20%
some	20% - 35%
and	35% - 50%

Groundwater Observations

@ _____ ft.

@ _____ ft. after _____ hours

SOIL TEST BORING LOG & MONITORING WELL COMPLETION REPORT

OHI Engineering, Inc.
Engineers & Environmental Scientists

44 Wood Avenue
Mansfield, MA 02048
Voice: (508) 339-3929
Fax: (508) 339-2893

PROJECT:	*Art Park*	**BORING:**	**SB-3**
	69 Sever Street	**WELL:**	**NA**
	Worcester, Massachusetts	**SHEET:**	**1 of 1**

CONTRACTOR:	Geologic Earth Exploration, Inc.	**SIZE:**	2"	**SAMPLER:**	**START DATE:**	11/17/2022
GEOLOGIST/ENG.:	JJK	**WEIGHT:**	140 lb	Split Spoon	**FINISH DATE:**	11/17/2022
DRILL RIG:	Truck Mounted (Drive n'Wash)	**FALL:**	30"		**SURFACE GRADE:**	N/A

DEPTH (FT)	PID (ppmv)	BLOW COUNTS 0 - 6"	6" - 12"	12" - 18"	18" - 24"	REC		DESCRIPTION	DIAGRAM
+1	N/A					%			
1		1	4	4	6	50%		Loam Pink-Gray Fill (Brick and Ash) F-M Sand/ Silt w/ Pebbles	
2									
3		3	5	5	8	83%		Tan F SAND/SILT w/ Some Pebbles Tan-Gray M-C Sand w/ Trace F S/S	
4									
5		8	9	9	8	75%		Tan-Gray F SAND/SILT Tan-Gray M-C Sand w/ Trace F S/S	
6									
7									
8									
9									
10		13	23	17	15	50%		Wet. Gray-Blue F-C SAND/SILT w/ F-C Gravel and Cobbles GW @ ~ 9' bgs	
11									
12									
13									
14									
15		20	14	16	20	67%		Same as Above	
16									
17								End of Exploration @ ~ 16' bgs	
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									

Penetration Resistance

Cohesionless Density		Cohesive Consistency	
0 - 4	very loose	0 - 2	very soft
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10 - 29	med. dense	5 - 8	med. stiff
30 - 49	dense	9 - 15	stiff
50+	very dense	16 - 30	very stiff
		31+	hard

Terms

Proportion Definition	
trace	0% - 10%
little	10% - 20%
some	20% - 35%
and	35% - 50%

Groundwater Observations

@ _____ ft.

@ _____ ft. after _____ hours

OHI Engineering, Inc.
Engineers & Environmental Scientists

END OF REPORT

44 Wood Avenue
Mansfield, MA 02048
Tel (508) 339-3929
Fax (508) 339-3140

110 Pulpit Hill Road
Amherst, MA 01002
Tel (413) 835-0780

www.OHIengineering.com