CONSTRUCTION SPECIFICATIONS

FOREWORD

The MBTA's Standard Plans referred to herein is the book of plans entitled "MBTA Railroad Operations – Book of Standard Plans – Track and Roadway"; which is available at a charge of $30.00 at MBTA Contract Administration, Room 5610, Transportation Building, 10 Park Plaza, Boston, MA 02116. Also, the MBTA's Standard Plan entitled "MBTA Railroad Operations – Commuter Rail Design Standards Manual" is available at a charge of $35.00 per copy, payable by separate check. Bidding documents will be sent upon request and receipt of an additional fee of $15.00, payable by separate check. Plans referenced in this book are referred to as STANDARD PLAN (Number). None of these charges are refundable.

CONSTRUCTION SPECIFICATIONS
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APPENDIX A - MBTA RAILROAD OPERATIONS – GUIDELINES AND PROCEDURES FOR WORK ON MBTA PROPERTY

SECTION 02100

SITE PREPARATION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies the following items.

1. Clearing, grubbing, and disposing of vegetation, including bushes, brush, trees, stumps, fallen timber, logs, roots, rubbish, refuse, trash, and debris within the indicated limits.
2. Protection from injury or defacement of vegetation and objects indicated or designated by the Engineer to be preserved.
3. Removal, salvage, or other disposition of basement walls, slabs and footings; existing pavement, curbs and gutters, sidewalks, headwalls, walls, and steps; utility service facilities; guardrail and posts, highway and street signs and fences; and other miscellaneous structures and site improvements which interfere with construction, as indicated, or as required by the Engineer.
4. Placing of siltation fence and hay bales for erosion and sedimentary control.
5. Installing turbidity control floating curtain as indicated on Contract Documents
6. Preparing site access roadways, storage areas, and security fencing.
7. Removal of existing railroad ties and ballast across culvert and bridges as indicated.
8. Removal of existing deck timbers, ballast retainers and railings at bridges at M.P. 21.76 and 40.01.
9. Removal of existing timber retaining walls at culvert and bridges as indicated.
10. Removal of existing timber brackets from upstream face of bridge at M.P. 47.84.
11. Removing and resetting existing trackside guard rail.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 02221 - DEMOLITION.
2. Section 02300 – EARTHWORK: removal if items completely buried below grade.
3. Section 02650 - EXISTING SITE UTILITIES: maintenance, support, protection, relocation, reconstruction, adjusting-to-grade, restoration and abandonment of existing utilities.

C. The Massachusetts Bay Commuter Rail (MBCR) will be removing and resetting or replacing existing rails and ties within the project limits, except for the railroad ties across bridges as indicated. The Contractor will be responsible for removing existing railroad ties across the bridges at M.P. 21.76, 40.01, and the culvert at M.P. 8.65 and either storing them at a location designated by MBCR, or removal and disposal as may be directed by the Engineer. The Contractor will also be responsible for removal of existing stone ballast across the bridges and culvert.

1.2 SUBMITTALS

A. Submit copies of requests for and certificates of severance of utility services to the Engineer prior to start of site preparation work.

B. Prior to the start of work, the Contractor shall submit a Turbidity Control Floatation Barrier Curtain Plan for review and approval by the Engineer, indicating the proposed locations, materials/products and methods of installation and maintenance for the floating turbidity control curtain.

PART 2 - PRODUCTS

2.1 SILT FENCE

A. Steel posts shall be a minimum of five feet in length, two and one-half inch by two and one-half inch by one-quarter inch angle post with self-fastening tabs and a five inch by four inch (nominal) steel anchor plate bottom.

B. Welded wire fabric shall be four inch by four-inch mesh of twelve gauge by twelve gauge steel wire.

C. Silt fence shall be a woven, polypropylene, ultraviolet resistant material such as Beltech 940 Silt Fence, Mirafi 100X Silt Fence, Perma 2130 Silt Fence or equal.

D. Tie wires for securing silt fence fabric to wire mesh shall be light gauge metal clips (hog rings), or one-thirty second inch diameter soft aluminum wire.

E. Prefabricated commercial silt fence may be substituted for built-in-field fence such as Mirafi Envirofence, Celancese Corp Envirofence, AMXCO Silt Stop or equal.

2.2 HAY BALES

A. Hay bales shall consist of hay or straw for outdoor use, be banded with string or nylon cord (minimum two bands per bale) and shall be staked into the ground.

2.3 HAY BALE STAKES

A. Wood stakes for hay bales shall be two inch square by thirty-two inches long, hardwood stakes.

2.4 TURBIDITY CONTROL FLOATING BARRIER CURTAIN

A. **(BEING DEVELOPED)**

PART 3 - EXECUTION

3.1 PROTECTION

A. Protect indicated or designated trees with fencing to the approximate diameter of foliage to prevent damage to the trunk, foliage and root system by construction equipment or procedures.

B. Protect other plants, monuments, existing improvements, adjacent property, and facilities from damage.

C. Maintain protected vegetation in a healthy growing condition during construction.

D. The Contractor shall not damage, remove or destroy any tree unless designated by the Engineer as a tree to be removed. In the event that the Contractor severely damages, removes or destroys an existing tree designated to be saved, the Contractor shall promptly replace any such damaged, removed, or destroyed tree 12 inches in caliper or smaller with a tree of the same size and variety at no cost to the Authority.

E. The Contractor shall promptly replace any such damaged, removed or destroy tree greater than 12 inches in caliper with a 12 inch caliper tree of the same variety.

F. The Contractor shall monitor and guarantee the survival of any such replacement tree for a period of two years from the date of replacement.

G. The Contractor shall use all necessary precautions to prevent damage to Authority or private property and to avoid hazardous exposure and personal injury to workmen.

H. The use of herbicides is strictly prohibited.

I. Protect existing stone/concrete bounds and monumentation along property lines. Any disturbed bound/monumentation shall be reset by a Registered Land Surveyor at no additional cost to the Authority.

3.2 CLEARING AND GRUBBING

A. Clear materials specified herein to the limits shown and remove from the site. Remove stumps and roots completely in excavation areas and under embankments where the original ground level is within 3.5 feet of the sub-grade or slope of embankments. In embankment areas where the original ground level is more than 3.5 feet below the sub-grade or slope of embankment, cut off trees, stumps, and brush to within six inches of the ground.

B. Do not start earthwork operations in areas where clearing and grubbing is not complete, except that stumps and large roots may be removed concurrently with excavation.

C. Where the work includes the removal of elm trees or the branches or stumps of elm trees, dispose of such material immediately after cutting or removal, by covering with earth to a depth of at least six inches in areas off the jobsite where such disposal has been arranged.

D. Where the work under the Contract includes the provision of wood chip mulch, acceptable material from clearing and grubbing activities may be used to produce such mulch. Material obtained from elm trees will not be acceptable for such use.

E. Timber Disposal

1. The Contractor shall be responsible for disposal of timber removed from existing retaining walls at an approved facility.
2. Timber crossties, bridge deck timbers and any timbers previously discarded on site by others shall be included for disposal.
3. Disposal of ties, tie butts, and switch timbers shall be accomplished at an approved facility.
4. The processing and disposal facility/facilities shall be fully licensed and permitted for handling, processing, storing, and incinerating treated wood waste.

5. Bottom ash, fly ash, and other by-product residues from combustion process shall be disposed of at a fully licensed landfill.

6. Identified combustion facilities must be approved by the Authority's Project Manager prior to commencement of delivery of removed ties.

7. The Contractor shall provide the Engineer with a copy of a certified weight slip for each quantity shipped, unloaded, and properly disposed of at the licensed facility.

3.3 TREE BRANCHES

A. Remove tree branches overhanging trackways, roadways, and other designated areas of the site to within 20 feet of the finish grade. Cut off branches neatly close to the tree boles. Remove other branches as necessary to present a balanced appearance. Treat scars resulting from tree branch removal with a heavy coat of an approved asphaltic tree paint.

3.4 REMOVAL

A. Remove entirely existing miscellaneous structures and site improvements that interfere with construction, as indicated, or as designated by the Engineer. Remove walls and masonry construction to a minimum depth of two feet below existing ground level in areas where such items do not interfere with construction.

B. Abandoned Rail and Other Track Materials. Contractor to coordinate with MBCR with regard to ownership, removal, and disposal of off site of abandoned rail and OTM located between boundaries two feet outside of the outermost rail and including the space between double tracks.

C. Slabs may be broken and left in place where the Engineer determines it is not detrimental to the structural integrity of the fill or structure to be placed above.

D. All removal must be done in accordance with applicable state and federal laws.

E. Removal of deck timber from the bridge at M.P. 40.01 shall be done in a manner that will not damage the existing steel girders to remain. The Contractor shall use all necessary precautions to prevent damage to the existing steel girders.

3.5 SALVAGE

A. Salvage indicated material or material determined by the Engineer to be suitable for reuse, including: grates, frames, other metal castings and miscellaneous parts of inlets and manholes; hydrants, fire alarm posts and boxes; metal light poles; sound pipe and valves; metal fencing; guard rail; and highway and street signs and posts.

B. Protect metallic coatings on salvaged items. Remove adhering concrete from salvaged items.

C. Repair, or replace with new material, salvaged material damaged or destroyed due to the Contractor's negligence.

3.6 BACKFILL

A. Backfill and compact trenches and excavations resulting from work under this Section in accordance with Section 02300 - EARTHWORK.

3.7 SILT FENCE AND HAY BALE INSTALLATION

A. Silt fence and hay bales shall be positioned as indicated on the Drawings and as necessary to prevent off site movement of sediment produced by construction activities as directed by the Engineer and as shown on the Drawings.

B. Dig trench approximately six inches wide and six inches deep along proposed fence lines.

C. Drive metal-stakes, eight feet on center (maximum) at back edge of trenches. Stakes shall be driven two feet (minimum) into ground.

D. Hang four by four woven wire mesh on posts, setting bottom of wire in bottom of trench. Secure wire to posts with self-fastening tabs.

E. Hang filter fabric on wire carrying to bottom of trench with about four (4) inches of fabric laid across bottom of trench. Stretch fabric fairly taut along fence length and secure with tie wires eighteen inches on center both ways.

F. Backfill trench with excavated material and tamp.

G. Install a single row of hay bales, as indicated on the Drawings, against the siltation fence and stake with two hardwood stakes per bale. Also place hay bales around existing down-stream catch basins in the vicinity of the project.

H. Furnish, place and maintain silt fence and hay bales as specified and as shown on the Drawings. Remove upon completion of all work.

3.8 TURBIDITY CONTROL FLOATING BARRIER CURTAIN

A. **(BEING DEVELOPED)**

3.9 MAINTENANCE AND INSPECTIONS

A. Inspections: Contractor shall make a visual inspection of all sedimentation control devises once per week and promptly after every rainstorm. If such inspection reveals that additional measures are needed to prevent movement of sediment to off site areas, the Contractor shall promptly install additional devices as needed. Sediment controls in need of maintenance shall be repaired promptly. Maintain stockpiles on site of siltation fence, hay bales and repair kits.

B. Maintenance:

1. Silt Fences and Hay Bales
   a. Remove accumulated sediment once it builds up to one-half inch of height of the silt fence.
   b. Replace damaged fabric, or patch with a two foot minimum overlap

c. Make other repairs as necessary to ensure that the fence is filtering all runoff directed to the fence

d. Replace hay bales when saturated with silt or otherwise damaged.

3.10 REMOVE AND RESET TRACKSIDE GUARD RAIL

A. Existing Trackside steel guard rail will be removed and reset at the location shown on the drawings. Use new hardware to reassemble the guard rail.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Separate measurement and payment will not be made for preparing the site for construction of the Bridge and Culvert improvements identified on the plans, including clearing, grubbing and disposing of vegetation, including bushes, brush, trees, stumps, etc., removing and disposing of all trash, debris, etc., and all other work associated with the preparation of the construction sites, but all costs in connection therefore shall be included in the Contract Lump Sum Price for Item 0210.000 – Clearing of Site, including all incidentals.

B. Separate measurement and payment will not be made for preparing the station improvements site for construction including clearing, grubbing and disposing of vegetation, including bushes, brush, trees, stumps, etc., removing and disposing of all trash, debris, etc., removing and resetting the section of existing trackside guard rail, and all other work associated with the preparation of the construction sites, but all costs in connection therefore shall be included in the Contract Lump Sum Price for Item 0220.098 – Site Preparation, including all incidentals.

C. Erosion Control System, consisting of silt fence and hay bales for erosion control barriers, will be measured by the number of linear feet complete in place, including reuse and relocation, as directed and approved by the Engineer.

D. Separate measurement and payment will not be made for turbidity control floating barrier curtain, but all costs in connection therefore shall be included in the Contract Lump Sum Price for Item 0220.050 – Turbidity Control Floating Barrier Curtain, including all incidentals.

E. Removal and incineration of all timber removed from existing bridge decks, ballast retainers and retaining walls as shown on the contract plans and within the Project Limits will be measured by the ton.

F. Removal and incineration of all scrap cross ties and switch timbers within the Project Limits will be measured by the ton.

G. Removal and storage of existing railroad cross ties and switch timbers across the bridges and culvert will be measured by the unit Each, complete in place, under Item 0294.953 – Salvage Cross Ties and Switch Timbers.

4.2 PAYMENT

A. Clearing of site shall include the removal and disposition of existing trees, shrubs, miscellaneous vegetation, stone ballast across the bridges and culvert, rubbish, trash and other debris from the right-of-way. Excavating and backfilling incidental to work under this Section will not be separately paid for, and all costs in connection therewith shall be included in the prices for the items of work to which the excavating and backfilling is incidental. Work included under clearing of site will not be measured separately, but will be included in the Contract Lump Sum Price bid for Item 0210.000 – Clearing of Site.

B. Payment for preparation of the station improvements site will be made at the Contract Lump Sum Price bid for Item 02220.098 - Site Preparation, for the work and measurement as specified above.

C. Payment for erosion control system will be made at the Contract Unit Price Bid for Item 0282.202 – Erosion Control System, which price shall include all costs associated with furnishing, installing, inspecting, maintaining and removal upon completion of the work, silt fence and hay bales for erosion control. Payment will include all equipment, materials, labor, submittals, permits and incidentals required to perform the work at locations indicated in the Contract Documents and to the satisfaction of the Engineer.

D. Payment for turbidity control floating barrier curtain will be made at the Contract Lump Sum Price Bid for Item 0220.050 – Turbidity Control Floating Barrier Curtain, which price shall include all costs associated with furnishing, installing, inspecting, maintaining and removal upon completion of the work, floating barrier curtain for turbidity control. Payment will include all equipment, materials, labor, submittals, permits and incidentals required to perform the work at locations indicated in the Contract Documents and to the satisfaction of the Engineer.

E. Payment for removal and disposal of timber removed from existing bridge decks, railings, ballast retainers and retaining walls will be made at the Contract Unit Price Bid for Item No. 0290.901 - Incinerate Ties and Timber, which price shall include all costs associated with the removal, stock piling, handling and rehandling, transportation, incineration, and disposal of timber ties, including all equipment, materials, labor, submittals, permits and incidentals required to perform the work to the satisfaction of the Engineer. Payment will be made based on certified weight slips submitted as specified.

F. Payment for removal and disposal of existing railroad crossties will be paid at the Contract Unit Price Bid for Item 0290.901 - Incinerate Ties and Timber, which price shall include all costs associated with the removal, stock piling, handling and rehandling, transportation, incineration, and disposal of ties, including all equipment, materials, labor, submittals, permits and incidentals required to perform the work to the satisfaction of the Engineer. Payment will be made based on certified weight slips submitted as specified.

G. Payment for removal and storage of existing railroad cross ties and switch timbers across the bridges and culvert will be paid at the Contract Unit Price Bid for Item 0294.953 – Salvage Cross Ties and Switch Timbers, which price shall include all labor, materials, equipment, transportation, and all incidentals necessary to remove and stack the ties and timbers at a location designated by the Engineer.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0210.000	CLEARING OF SITE	LS
0220.050	TURBIDITY CONTROL FLOATING BARRIER CURTAIN	LS
0220.098	SITE PREPARATION	LS
0282.202	EROSION CONTROL SYSTEM	LF
0290.901	INCINERATE TIES AND TIMBER	TN
0294.953	SALVAGE CROSS TIES AND SWITCH TIMBERS	EA
0271.004	REMOVE EXISTING FENCES	EA

END OF SECTION

SECTION 02221

DEMOLITION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies the following items:

1. Demolition, selective demolition and removal of structures and buildings.
2. Demolition, selective demolition and removal of site improvements.
3. Removing below-grade construction.
4. Disconnecting, capping or sealing, and removing site utilities.
5. Salvaging items for reuse by the Authority.

B. Work specified under this Section includes demolition work for bridges and culverts identified on the Contract Documents and identified as follows:

1. Removal salvage or other disposition of the existing superstructure elements including steel girders, diaphragms, cross bracing lateral bracing, connection plates, bearings, concrete deck panels, rail section and brick and concrete masonry culvert roof construction, and other superstructure elements.

2. Removal salvage or other disposition of portions of existing substructure elements including concrete backwalls, bridge seats and wingwall caps to the limits shown on the Contract Documents and as directed by the Engineer. Removal may be accomplished using pneumatic chipping hammers no larger than the 25 pound class. The Contractor shall be responsible for any damage to existing substructure to remain and shall repair such damage at no expense to the Authority.

3. Removal salvage or other disposition of portions of existing substructure elements including stone masonry bridge seats, breast walls, and wingwalls to the limits shown on the Contract Documents and as directed by the Engineer. The Contractor shall be responsible for any damage to existing substructure to remain and shall repair such damage at no expense to the Authority.

4. Removal and disposal of deteriorated steel sheet piling extending above the pier footing at the Sudbury River Bridge (MP 20.48).

C. The Contractor shall note that the **BRIDGE STRUCTURES ARE COATED WITH LEAD BASED PAINTS**. The proper testing, handling, cutting, removal and disposal shall follow all applicable city, state and federal guidelines in the demolitions of the bridge structures.

D. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 01300 Submittals.
2. Section 01571 Maintenance and Protection of Railroad Traffic.
3. Section 02090 Lead Based Paint Abatement.

4. Section 02100 Site Preparation.
5. Section 02300 Earthwork for removal of portions of existing stone masonry substructure as indicated.
6. Section 05100 Structural Steel for removal of selective deteriorated structural steel in preparation for repairs.
7. Division 15 Sections for demolishing or relocating site mechanical items.
8. Division 16 Sections for demolishing or relocating site electrical items.

1.2 DEFINITIONS

A. Demolish: Completely remove and legally dispose of off-site.

B. Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Authority ready for reuse. Include fasteners or brackets needed for reattachment elsewhere.

C. Hazardous Material: include but is not limited to asbestos and materials regulated under TSCA, RCRA (310CMR 30.00) and the Massachusetts Contingency Plan (MCP) (310 CMR 40.00) and building construction material defined by OSHA. Where applicable, consideration should be given to MSDS in determining if a material could be potentially hazardous.

1.3 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Authority that may be uncovered during demolition remain the property of Authority.

1. Carefully salvage in a manner to prevent damage and promptly return to Authority.

1.4 SUBMITTALS

A. Proposed Protection Measures: Submit informational report in accordance with OSHA Part 1926 procedures, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.

1. Adjacent Buildings and Structures: Detail special measures proposed to protect adjacent buildings and structures to remain.

B. Schedule of Building Demolition Activities: Indicate the following:

1. Detailed sequence of demolition work, with starting and ending dates for each activity.
2. Temporary interruption of utility services.
3. Shutoff and capping or re-routing of utility services.

C. Building Demolition Plans: Drawings indicating the following:

1. Locations of temporary protection and means of egress for adjacent occupied buildings.

D. Inventory: Submit a list of items to be removed and salvaged and deliver to Authority prior to start of demolition.

E. Predemolition Photographs or Video: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by building demolition operations. Comply with Division 1. Submit before the Work begins.

F. Hazardous material remediation plan. Included in the plan are landfill records indicating receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

G. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

H. Results of Professional Engineer's survey required by Article 3.1D.

I. Submit a Demolition Staging Plan for the work, including as a minimum, copies of all required permits included lead paint removal measures, plans for containment to protect the waterways below the bridge at each location as necessary, dust and sediment control, final grading and site restoration plans.

J. All submissions shall be approved before work may proceed

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI A10.6 and NFPA 241.

C. Prepare a hazardous material remediation plan and submit to Authority for approval.

D. Predemolition Conference: Conduct conference at Project site to review methods and procedures related to building demolition including, but not limited to, the following:

1. Review of hazardous material remediation plan.
2. Inspect and discuss condition of construction to be demolished.
3. Review structural load limitations of existing structures.
4. Review and finalize building demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
5. Review and finalize protection requirements.
6. Review procedures for noise control and dust control.
7. Review procedures for protection of adjacent buildings.
8. Review items to be salvaged and returned to Authority.

1.6 PROJECT CONDITIONS

A. Buildings to be demolished will be vacated and their use discontinued before start of the Work.

B. Buildings immediately adjacent to demolition area may be occupied. Conduct building demolition so operations of occupied buildings will not be disrupted.

1. Provide not less than 72 hours notice of activities that will affect operations of adjacent occupied buildings.
2. Maintain access to existing walkways, exits, and other facilities used by occupants of adjacent buildings.
   a. Do not close or obstruct walkways, exits, or other facilities used by occupants of adjacent buildings without written permission from authorities having jurisdiction.

C. The Authority assumes no responsibility for buildings and structures to be demolished.

1. Conditions existing at time of inspection for bidding purpose will be maintained by Authority as far as practical.

D. Hazardous Materials: Hazardous materials may be present in buildings and structures to be demolished. A report on the presence of hazardous materials is on file at the Authority for review and use. Examine report to become aware of locations where asbestos, lead paint or other hazardous materials are present. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified or required by a licensed professional and/or agency having jurisdiction.

E. On-site storage or sale of removed items or materials is not permitted.

F. Construction Access and Staging

1. Special attention shall be given to sequence demolition staging work so the MBTA Commuter Rail operations are not affected with respect to safety, operation and schedule.
2. All materials removed as part of this demolition shall become the property of the Contractor and are to be disposed of properly according to applicable local, State and Federal regulations, unless otherwise specified by the Engineer.

1.7 COORDINATION

A. Arrange demolition schedule so as not to interfere with Authority's operations and operations of adjacent occupied buildings.

B. Demolition shall proceed in sections. The demolition work must be performed in conjunction with the approved sequence of construction plans.

C. A minimum of one track must be in operation at all times. This track will be active during all demolition activities. The contractor must take steps to ensure that his operations will not impact rail service.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting demolition operations.

B. Review Project Record Documents of existing construction provided by Authority. Authority does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.

D. Engage a professional engineer to perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during building demolition operations.

E. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

3.2 PREPARATION

A. Existing Utilities: Locate, identify, disconnect, and seal or cap off indicated utilities serving buildings and structures to be demolished.

1. Arrange to shut off indicated utilities with utility companies.
2. If removal, relocation, or abandonment of utility services will affect adjacent occupied buildings, then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
3. Cut off pipe or conduit a minimum of 24 inches below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.

B. Existing Utilities: Refer to Division 15 and 16 Sections for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing.

C. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of demolition.

D. Salvaged Items: Comply with the following:

1. Clean salvaged items of dirt and demolition debris.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Authority.
4. Transport items to storage area designated by Authority.
5. Protect items from damage during transport and storage.

3.3 PROTECTION

A. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.

B. Existing Utilities: Maintain utility services to remain and protect from damage during demolition operations.

1. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by Authority and authorities having jurisdiction.
2. Provide temporary services during interruptions to existing utilities, as acceptable to Authority and authorities having jurisdiction.
   a. Provide at least 72 hours notice to occupants of affected buildings if shutdown of service is required during changeover.

C. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction and as indicated. Comply with requirements in Division 1.

1. Protect adjacent buildings and facilities from damage due to demolition activities.
2. Protect existing site improvements, appurtenances, and landscaping to remain.
3. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
4. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
5. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
6. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.
7. Erect and maintain dustproof partitions and temporary enclosures to limit dust, noise, and dirt migration to occupied portions of adjacent buildings.

D. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

3.4 DEMOLITION, GENERAL

A. General: Demolish indicated existing buildings and site improvements completely. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
2. Maintain fire watch during and for at least four hours after flame cutting operations.
3. Maintain adequate ventilation when using cutting torches.
4. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
5. In general, demolish buildings top down.

B. Engineering Surveys: During demolition, perform surveys to detect hazards that may result from building demolition activities.

C. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Authority and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

D. Explosives: Use of explosives is not permitted.

3.5 DEMOLITION BY MECHANICAL MEANS

A. Proceed with demolition of structural framing members systematically, from higher to lower level. Complete building demolition operations above each floor or tier before disturbing supporting members on the next lower level.

B. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

1. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.

C. Salvage: Items to be salvaged are indicated on Drawings.

D. Below-Grade Construction: Demolish foundation walls and other below-grade construction that are within footprint of new construction and extending 5 feet outside footprint indicated for new construction. Abandon below-grade construction outside this area.

1. Remove below-grade construction, including basements, foundation walls, and footings, to at least depths indicated.

E. Existing Utilities: Abandon existing utilities and below-grade utility structures. Cut utilities flush with grade unless indicated otherwise.

3.6 SITE RESTORATION

A. Below-Grade Areas: Rough grade below-grade areas ready for further excavation or new construction.

B. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

3.7 REPAIRS

A. Promptly repair damage to adjacent buildings, utilities, fences, or other structures caused by demolition operations.

3.8 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site and legally dispose of them in an EPA-approved landfill acceptable to authorities having jurisdiction.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Do not burn demolished materials.

3.9 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. No separate measurement will be made for demolition but all costs in connection therewith shall be included in the Lump Sum prices for removal and disposal of the existing structures as identified on the contract plans. This work shall include all plans, calculations, submissions, and permits, including all labor, equipment, accessories and incidentals to complete work to the satisfaction of the engineer. All costs associated with lead paint removal/disposal, permits and submissions or costs associated with proper disposal of painted steel shall be included in the lump sum bid prices. All preparation and incidental work necessary to accomplish the removals will be considered incidental to the Lump Sum prices.

4.2 PAYMENT

A. Payment for demolition will be made at the Contract lump sum prices for the quantities determined as specified above.

B. All demolition work at Mill Pond Bridge (MP 40.01) will be paid at the Contract Lump Sum Price Bid for Item 0211.000 – Demolition, which price shall include all costs associated with removal of portions of the existing concrete backwall and wingwall caps as shown on the Contract Documents, including all equipment, materials, labor, submittals, permits and incidentals, including excavation and backfill, required to perform the work to the satisfaction of the Engineer.

C. All demolition work at Assabet River Bridge (MP 21.76) will be paid at the Contract Lump Sum Price Bid for Item 0211.404 – Remove and Dispose of Present Bridge No.1, which price shall include all costs associated with removal of the existing steel superstructure as shown on the Contract

Documents, including all equipment, materials, labor, submittals, permits and incidentals, including excavation and backfill, required to perform the work to the satisfaction of the Engineer.

D. All demolition work at West Acton Bridge (MP 27.46) will be paid at the Contract Lump Sum Price Bid for Item 0211.405 – Remove and Dispose of Present Bridge No.2, which price shall include all costs associated with removal of the existing concrete deck panel superstructure as shown on the Contract Documents, including all equipment, materials, labor, submittals, permits and incidentals, including excavation and backfill, required to perform the work to the satisfaction of the Engineer.

E. All demolition work at Waltham Culvert (MP 8.65) will be paid at the Contract Lump Sum Price Bid for Item 0211.406 – Remove and Dispose of Present Bridge No.3, which price shall include all costs associated with removal of the existing rail section, brick and concrete superstructure as shown on the Contract Documents, including all equipment, materials, labor, submittals, permits and incidentals, including excavation and backfill, required to perform the work to the satisfaction of the Engineer.

F. All demolition work at Sudbury River Bridge (MP 20.48) will be paid at the Contract Lump Sum Price Bid for Item 0211.250 – Demolition and Restoration, which price shall include all costs associated with cutting, removal and disposal of the top portion of steel sheet piling surrounding the center pier footing, removal and disposal of vegetation and debris build up on top of the pier footing as shown on the Contract Documents, including all equipment, materials, labor, submittals, permits and incidentals required to perform the work to the satisfaction of the Engineer.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0211.000	DEMOLITION	LS
0211.250	DEMOLITION AND RESTORATION	LS
0211.404	REMOVE AND DISPOSE OF PRESENT BRIDGE NO. 1	LS
0211.405	REMOVE AND DISPOSE OF PRESENT BRIDGE NO. 2	LS
0211.406	REMOVE AND DISPOSE OF PRESENT BRIDGE NO. 3	LS

END OF SECTION

SECTION 02240

DEWATERING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies dewatering to facilitate subsurface construction.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 02260 – Excavation Support and Protection.
2. Section 02300 – Earthwork: for excavating, backfilling, site grading and site utilities.
3. Appendix A – Relevant Articles

1.2 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control groundwater flow into excavations and permit construction to proceed on dry, stable sub-grades.

1. Maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to sub-grades and permanent structures is prevented.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Accomplish dewatering without damaging existing buildings adjacent to excavation.
4. Remove dewatering system if no longer needed.
5. Provide for legal and suitable disposal of groundwater.
6. Evaluate existing soil conditions and propose equipment and techniques to dewater both non-cohesive and cohesive soils.

1.3 SUBMITTALS

A. Shop Drawings for Information: For dewatering system. Show arrangement, locations, and details of wells and well points; locations of headers and discharge lines; and means of discharge and disposal of water.

1. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
2. Include a written report outlining control procedures to be adopted if dewatering problems arise.
3. Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.

B. Qualification Data: For installer and professional engineer.

C. Photographs or videotape, sufficiently detailed, of existing conditions of adjacent structures and site work that might be misconstrued as damage caused by dewatering operations.

D. Record drawings at Project Closeout identifying and locating capped utilities and other subsurface structural, electrical, or mechanical conditions performed during dewatering.

1. Note locations and capping depth of wells and well points.

E. Field Test Reports: Before starting excavation, submit test results and computations demonstrating that dewatering system is capable of meeting performance requirements.

F. Adjacent Foundations Report and Analysis: Record subsurface foundation systems of adjacent structures and evaluate impacts of groundwater removal; i.e. wood foundations and similar items.

G. The Contractor shall dewater for the length of time necessary to complete the specified sub-surface improvements. Dewatering operations shall be stopped based on a mutual decision between the Contractor and the engineering consultant. Any requirements to remove portions of the dewatering system will be noted on the Drawings.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.

B. Professional Engineer: Engage a professional engineer to design and certify dewatering systems. Engineer shall have a minimum of 5 years experience with type of dewatering systems similar to those proposed for use.

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Authority or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.

B. 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. Authority will not be responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
2. The geotechnical report is available from the Authority.

C. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Engineer if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent structures.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PREPARATION

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

1. Prevent surface water and subsurface or groundwater from entering excavations, from ponding on prepared sub-grades, and from flooding site and surrounding area.
2. Protect sub-grades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Authority and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.

C. Provide an adequate system to lower and control groundwater to permit excavation, construction of structures, and placement of fill materials on dry sub-grades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, sub-grade softening, and slope instability.

D. Reduce hydrostatic head in water-bearing strata below sub-grade elevations of foundations, drains, sewers, and other excavations.

1. Maintain piezometric water level a minimum of 24 inches below surface of excavation.

E. Dispose of water removed by dewatering in a manner that avoids negative impacts on abutters, endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

F. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Authority.

1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

3.3 OBSERVATION WELLS

A. Provide, take measurements, and maintain at least the minimum number of observation wells or piezometers indicated and additional observation wells as may be required by authorities having jurisdiction.

B. Observe and record daily elevation of ground water and piezometric water levels in observation wells.

C. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. Suspend construction activities in areas where observation wells are not functioning properly until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.

1. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

A. Separate measurement and payment will not be made for work required under this Section, but all costs in connection therefore shall be included in the items of work to which it pertains.

END OF SECTION

SECTION 02250

STORM WATER POLLUTION PREVENTION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The work specified in this Section includes requirements for the preparation and implementation of a Storm Water Pollution Prevention Plan required by the National Pollutant Discharge Elimination System (NPDES) and applicable Construction General Permit.

B. Pursuant to the Federal Clean Water Act, effective June 30, 2008 construction activities which disturb one acre or more are required to apply to the U.S. Environmental Protection Agency (EPA) for coverage under the NPDES General Permit for Storm Water Discharges From Construction Activities. On July 14, 2008 (Federal Register/Vol. 73, No. 135/pp. 40338 - 40343), EPA published the final NPDES General Permit for Stormwater Discharges From Construction Activity.

C. Related work described elsewhere:

1. Section 01500 - CONSTRUCTION TEMPORARY FACILITIES
2. Section 02100 - SITE PREPARATION
3. Section 02240 - DEWATERING
4. Section 02282 - HANDLING TRANSPORTATION & DISPOSAL OF EXCAVATED MATERIALS
5. Section 02300 - EARTHWORK
6. Section 02920 – LAWNS

1.2 SUBMITTALS

A. Contractor shall refer to Section 01300 for submittal procedures.

B. Submit Storm Water Pollution Prevention Plan in accordance with the requirements of Article 1.3 of this Section. Resubmit as appropriate during the progress of the Work to reflect proposed revisions and changed conditions; Appendices need not be included with these resubmittals. However, the Contractor is advised that submittal of selected items contained therein, or copies of same, are required to be submitted by other provisions of this Section or other Sections of these Contract Documents. At completion of the Work, and before final payment is made, Contractor shall submit one copy of final Storm Water Pollution Prevention Plan, including all Appendices.

1.3.1 NPDES NOTICE OF INTENT

A. The NPDES General Permit requires the submission of a Notice of Intent (NOI) to the U.S. EPA prior to the start of construction (defined as any activity which disturbs land, including clearing and grubbing). There is a seven (7) day review period commencing from the date on which EPA enters the

Notice into their database. The Contractor is advised that, based on the review of the NOI, EPA may require additional information, including but not limited to, the submission of the Storm Water Pollution Prevention Plan for review. Work may not commence on the project until final authorization has been granted by EPA. Any additional time required by EPA for review of submittals will not constitute a basis for claim of delay.

B. The operator of the construction site, the Contractor, must submit the NOI. In cases where the municipality or other party has control over the plans and specifications or day-to-day site operations, said party must also submit a NOI. The Contractor is responsible to ensure that all required parties have submitted a NOI and shall provide proof of same to the Engineer. The Contractor may file a Notice of Intent form using EPA's eNOI system at: www.epa.gov/npdes/eNOI.

C. In addition, if the project discharges to an Outstanding Resource Water, vernal pool, or is within a coastal ACEC as identified by the Massachusetts Department of Environmental Protection (DEP), a separate notification to DEP is required. If required, said notification shall be made in accordance with DEP BRP WM09, Approval of NPDES Stormwater Pollution Prevention Plans for Construction or Industrial General Permits Discharging to Outstanding Resource Waters. DEP may also require submission of the Storm Water Pollution Prevention Plan for review and approval. Filing fees associated with the notification and, if required, the SWPPP filing to DEP shall be paid by the Contractor. Any additional time required by DEP for review of submittals, SWPPP approval and issuance of BRP WM09 shall not constitute a basis for claim of delay.

1.4 STORM WATER POLLUTION PREVENTION PLAN

A. The General Permit also requires the preparation and implementation of a Storm Water Pollution Prevention Plan (SWPPP) in accordance with the afore-mentioned statutes and regulations. The Plan will include the General Permit conditions and detailed descriptions of controls of erosion and sedimentation to be implemented during construction. It is the responsibility of the Contractor to prepare the SWPPP to meet the requirements of the most recently issued CGP, including but not limited to the requirements of the U.S. EPA's Developing Your Pollution Prevention Plan A Guide for Construction Sites (Office of Water/EPA 833-R-06-004/May 2007), and the requirements of this Section. The Contractor shall submit the Plan to the Engineer for approval at least four weeks prior to any site activities. It is the responsibility of the Contractor to be familiar with the General Permit conditions and the conditions of any state Wetlands Protection Act Order, Water Quality Certification, Corps of Engineers Section 404 Permit and other environmental permits applicable to this project and to include in the Stormwater Pollution Prevention Plan the methods and means necessary to comply with applicable conditions of said permits.

B. It is the responsibility of the Contractor to complete the SWPPP in accordance with the EPA Construction General Permit, provide all information required, and obtain any and all certifications as required by the Construction General Permit. Any amendments to the SWPPP required by site conditions, schedule changes, revised work, construction methodologies, and the like are the responsibility of the Contractor. Amendments will require the approval of the Engineer prior to implementation.

C. Included in the General Permit conditions is the requirement for inspection of all erosion controls and site

conditions on a weekly basis as well as after each incidence of rainfall exceeding 0.5 inches in twenty-four hours. The Contractor shall choose a qualified individual who will be on-site during construction to perform these inspections. The name and qualifications of the inspector shall be submitted to the Engineer for approval in accordance with subcontractor approval requirements. In addition, if the Engineer determines at any time that the inspector's performance is inadequate, the Contractor shall provide an alternate inspector. Written weekly inspection forms, storm event inspection forms, and Monthly Summary Reports must be completed and provided to the Engineer. Monthly Summary Reports must include a summary of construction activities undertaken during the reporting period, general site conditions, erosion control maintenance and corrective actions taken, the anticipated schedule of construction activities for the next reporting period, any SWPPP amendments, and representative photographs. The inspector qualifications, inspection reports and monthly reports shall also conform to the requirements of the Wetlands Order of Conditions issued by any Conservation Commissions with jurisdiction over the work.

D. The Contractor is responsible for preparation of the Plan, all SWPPP certifications, inspections, reports and any and all corrective actions necessary to comply with the provisions of the General Permit. This Item addresses acceptable completion of the SWPPP, any revisions/amendments required during construction, inspection reports and preparation of monthly reports. In addition, any erosion controls beyond those specified in bid items elsewhere in this contract which are selected by the Contractor to facilitate and/or address the Contractor's schedule, methods and prosecution of the work shall be considered incidental to this item.

1.5 NPDES NOTICE OF TERMINATION

A. The CGP requires the submission of a Notice of Termination (NOT) from all operators when final stabilization has been achieved. Approval of final stabilization by the Engineer and confirmation of submission of the NOT by the Contractor will be required prior to submission of the Resident Engineer's Final Estimate.

1.6 PENALTIES

A. Failure to comply with provisions of the NPDES permitting program and the Storm Water Pollution Prevention Plan may result in penalties assessed by the U.S. Environmental Protection Agency, the costs of which would be borne by the Contractor.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 IMPLEMENTATION OF THE STORM WATER POLLUTION PREVENTION PLAN

A. The Storm Water Pollution Prevention Plan, developed in accordance with Paragraphs 1.02 B. and 1.03 of this Section, shall be implemented and adhered to during all phases of construction at the Fitchburg Maine Line Right-of-Way site. The Contractor shall retain an up-to-date copy of his Storm Water Pollution Prevention Plan and all Appendices at an on-site construction project office. Such Plan, including all Appendices, shall be available for inspection during normal working hours by the Engineer, the Authority, and all duly-authorized Federal, State, and local officials from the date of initial Plan submittal until the final copy is submitted upon completion of the Work in accordance with the requirements of Paragraph 1.2 B.

B. The Contractor shall develop appropriate plans, figures, related sketches, etc. as necessary to illustrate the Storm Water Pollution Prevention Plan. Such items shall be maintained in an Appendix to the Storm Water Pollution Prevention Plan as they are developed by the Contractor. At a minimum such drawings shall address the following three elements for the site - (1) Existing Site Conditions; (2) Site Plans (illustrating slopes after grading, areas of disturbance, drainage pattern, etc.); and (3) Site Controls (illustrating erosion and sediment measures, project construction waters management, OHM management, etc.) - with each element separately addressed on its own drawing or series of drawings.

C. The following inspection and maintenance practices shall be used to maintain erosion and sediment controls:

1. All control measures identified in the Storm Water Pollution Prevention Plan shall be inspected by a Contractor-designated individual at least once each week and following any storm event of 0.5 inches or greater.

2. All measures shall be maintained in good working order; if a repair is necessary, it shall be initiated within 48 hours of deficiency identification.

3. An Inspection and Maintenance Report shall be completed for each inspection by the individual who performed the inspection. Completed Inspection and Maintenance Reports shall be maintained in an Appendix to the Storm Water Pollution Prevention Plan. The Contractor-developed report form to be completed by the Contractor's inspector shall be submitted to the Engineer for approval, and shall address the control measures identified in the Storm Water Pollution Prevention Plan. A sample Inspection and Maintenance Report form is presented as Attachment 2 to this Section. Contractor shall further develop this form as necessary to list the specific control measures to be inspected and to provide additional detail based on his proposed work. Inspection activities performed by the Contractor shall in no way limit the Authority or Engineer from conducting their own inspections and identifying deficiencies to the Contractor for correction.

D. The Contractor shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) to achieve compliance with the conditions of the NPDES General Permit and with the requirements of the Storm Water Pollution Prevention Plan.

E. The Contractor shall maintain records of dates when major grading activities occur, dates of temporary or permanent cessation of construction, and dates of initiation of stabilization measures in an Appendix to the Storm Water Pollution Prevention Plan.

F. Oil and Hazardous Materials Management and Spill Control

1. For practices not more specifically addressed by federal, state, and local laws and implementing regulations or these Specifications, all oil and hazardous materials and all spills shall be managed in accordance with the Oil and Hazardous Materials Management and Spill Control Program presented in the Storm Water Pollution Prevention Plan.

2. Spills

   a. The NPDES General Permit does not relieve the Contractor of the reporting requirements of the Massachusetts Contingency Plan, 40 CFR Part 117, or 40 CFR Part 302. Where a release containing a hazardous substance in an amount equal to or in excess of a reporting quantity established under the Massachusetts Contingency Plan, 40 CFR Part 117, or 40 CFR Part 302, the Contractor is required to comply with the requirements of the aforementioned regulations. Spills of oil or hazardous material shall be reported to the Massachusetts Department of Environmental Protection and/or the National Response Center as appropriate, if the reportable quantity is exceeded. All spills of OHM, in any quantity shall be reported to the Authority.

   b. A spill report shall be prepared by the Contractor following each occurrence. Spill report shall present a description of the release, including quantity and type of material, date of spill, circumstances leading to the release, location of spill, response actions and personnel, documentation of notifications, and corrective measures implemented to prevent reoccurrence. Such reports shall be maintained in an Appendix to the Storm Water Pollution Prevention Plan.

   c. The Contractor shall identify an appropriately trained site employee involved with day-to-day site operations to be the spill prevention and cleanup coordinator. The name(s) of responsible spill personnel shall be posted in the material storage area and in the office trailer on site. Each employee shall be instructed that all spills are to be reported to the spill prevention and cleanup coordinator.

G. The Contractor shall be required to amend the Plan whenever there is a change in design, construction, operation, or maintenance, which has a significant effect on the potential for the discharge of pollutants to waters, including the addition of or change in location of storm water discharge points, or if the Plan proves to be ineffective in eliminating or significantly minimizing pollutants in storm water discharges or in otherwise achieving the general objectives of the Plan. Also, where warranted based on the results of an inspection by the Contractor or others, the site description, procedures, or other elements of the Plan shall be revised as appropriate; modifications called for by the inspection and resultant changes to the Plan shall be implemented within 7 calendar days following the inspection. In addition, the Plan shall be amended to identify any new subcontractor that will implement a measure of the Plan. Finally,

the Plan shall be amended to incorporate specific revisions if so directed by the Engineer, the Authority, or any duly-authorized Federal, State, or local official at any time during the performance of the Work under this Contract.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

A. The work specified in this Section for preparing, implementing, monitoring and maintaining the Storm Water Pollution Prevention Plan will not be measured for payment separately, but shall be considered as incidental to and included in the allowance, lump sum, or unit price cost of the individual bid items in the Bid Schedule to which the work pertains and shall include development and implementation of activities and measures to properly handle OHM and to prevent storm water pollution; as such the work shall also include installation, operation, maintenance, and removal of all facilities for the collection, containment, diversion, and disposal of surface and ground water as required for compliance with the Storm Water Pollution Prevention Plan, including all supervision, labor, materials, and equipment not specifically included but necessary for proper completion of the work.

END OF SECTION

SECTION 02260

EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies temporary soils excavation support and protection systems.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 02010 – GEOTECHNICAL INSTRUMENTATION
2. Section 02240 – DEWATERING; for dewatering excavations.
3. Section 02300 – EARTHWORK; excavating and backfilling for existing utilities.
4. Section 03371 – SHOTCRETE; for use in excavation support and protection.
5. Appendix A – MBTA Railroad Operations Directorate, Parts I, II and VII.

1.2 PERFORMANCE REQUIREMENTS

A. Design, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed construction loads.

1. Provide professional engineering services needed to assume engineering responsibility, including preparation of Shop Drawings and a comprehensive engineering analysis.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Install excavation support and protection systems without damaging existing buildings, pavements, and other improvements or facilities adjacent to excavation.
4. Provide vibration monitoring.
5. Prevent impacts on adjacent structures and utilities.

1.3 DESIGN CRITERIA

A. The Contractor is responsible for the design of all excavation support and protection.

B. Design the excavation support system in accordance with the earth pressures, and other detailed criteria indicated. Excavation support shall allow the safe and expeditious construction of the permanent structures without excessive movement or settlement of the ground, to prevent damage to, or movement or settlement of adjacent buildings, roadways, tracks, structures, or utilities, as shown on the Contract Drawings and as specified herein.

C. Design the excavation support system to support; earth pressures, unrelieved hydrostatic pressures, Railroad loads (E-80), HS20-44 traffic loads and any adjacent structure surcharge loads, utility loads, equipment and construction loads. HS20-44 load shall be as set forth by the latest edition of AASHTO Standard Specification for Highway Bridges. The contractor shall verify latest editions of AREMA Manual and AASHTO manuals are being used for design.

D. Consult official records of existing utilities, both surface and subsurface, and their connections to be fully informed on all existing conditions and limitations as they apply to this work and its relation to other construction work. Proceed with caution in areas of utility facilities. Expose them by hand excavation or by other methods acceptable to the utility owner. Protect existing utilities to remain within and adjacent to the work area in accordance with the requirements of authorities having jurisdiction over same. The Contractor is responsible for any damage to utilities caused by the Contractor's operations and shall restore them to equal or better operation at no additional cost to the Owner.

1.4 SUBMITTALS

A. Shop Drawings and Design Submittals: Prepared by or under the supervision of a qualified professional engineer for excavation support and protection systems.

1. Include Shop Drawings and design calculations signed and sealed by a qualified professional engineer, registered in the Commonwealth of Massachusetts, responsible for their preparation.

2. Written requests for use of temporary tie backs subject to review and approval by the Engineer.

B. Qualification Data: For Installer and professional engineer.

1. Work under this Section shall be performed by a qualified Contractor having a minimum of 5 years experience with support of excavation design and construction. The Contractor must demonstrate that the Contractor's key personnel or Subcontractor has installed, constructed, and completed work involving the installation of excavation support walls, including projects involving tiebacks on a minimum of five projects; and has competently managed and supervised the manpower, materials, equipment, and tools necessary to complete such work as required by the size and complexity of this contract; and that the work was successfully completed within the time frame allotted; and that the work was done to the satisfaction of the owner.

2. Furnish a project list of satisfactorily completed wall installations. The project list shall include the name of the owner for whom the Work was performed, the scope and value of the wall installations, and the names of the Contractor's or Subcontractor's Project Superintendent(s) and Assistant Superintendent(s) and their experience with the installation of excavation support walls. The list shall also include at least three projects of similar height and size where the design and installation of temporary bracing was required.

C. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems.

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Authority or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.

B. 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. Authority will not be responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.

2. The geotechnical report is included elsewhere in the Project Manual.

3. Borings and site history indicate below ground obstructions may be encountered. Such obstructions may include, but are not necessarily limited to, boulders, granite blocks, concrete from past structures, concrete and masonry retaining walls, granite block walls, and various other demolition and construction debris.

C. The Contractor shall monitor adjacent structures and improvements for vertical and lateral movement using survey techniques, employing a qualified professional engineer or land surveyor; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations prior to start of construction.

1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Engineer if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

1.6 QUALITY ASSURANCE

A. The Contractor shall engage a licensed professional engineer, registered in the Commonwealth of Massachusetts, to design, approve and inspect all excavation support areas on a periodic basis.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.

C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.

D. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.

E. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

F. Timber Piling: ASTM D 25, species listed in AWPA C3, pressure-treated in accordance with AWPA C3.

G. Seven Wire Strand: ASTM A 416, Grade 250 or 270, uncoated seven-wire, low-relaxation strand.

H. Grout: Suitable for service, minimum 4,000 psi.

2.2 TIEBACKS

A. The Contractor may use temporary tie backs to optimize the design in areas approved by the Engineer.

B. Tieback tendons shall be fabricated from single or multiple elements of the following:

1. Steel bars conforming to ASTM Designation A 722, "Uncoated High Strength Steel Bars for Prestressed Concrete."

2. Seven wire strand conforming to ASTM Designation A416, "Uncoated Seven Wire Stress Relieved Strand for Prestressed Concrete."

3. Wires conforming to ASTM Designation A 421, "Uncoated Stress Relieved Wire for Prestressed Concrete."

4. Compact seven wire strands conforming to ASTM Designation A 799 80, "Uncoated Seven Wire Compacted, Stress Relieved Steel Strand for Prestressed Concrete."

C. Anchorages shall be capable of developing 95 percent of the guaranteed minimum ultimate tensile strength of the prestressing steel elements. All anchor head assemblies shall be restressable.

D. The bearing plate shall be fabricated from structural steel and it shall be capable of developing 95 percent of the guaranteed minimum ultimate tensile strength of the tendon steel elements.

E. Centralizers shall be fabricated from any material, except wood, which is non detrimental to the prestressing steel elements. The centralizer shall position the tendon in the drill hole so a minimum of 0.5 inch of grout cover is provided around each anchor strand. Centralizers shall be spaced at maximum 10 ft. intervals in the stressing length and maximum 5 ft. intervals in the bonded length.

F. Cement Grout

1. Cement grout used for encapsulating tiebacks shall be a neat cement grout conforming to the shop drawing submittal for the tiebacks.

2. Non shrink grout made with TYPE I, II, or III Portland Cement conforming to ASTM C 150 specifications shall be used. Cement should be fresh and should not contain any lumps or other indications of hydration.

3. Appropriate measures shall be taken to preclude freezing of the grout prior to its reaching design strength.

4. Water for mixing grout shall be potable.

5. Cement grout utilized for tiebacks shall have sufficient strength to achieve an effective bond between grout and the anchor tendon.

6. Redesign of the cement grout mix shall be conducted by the Contractor if performance and/or proof tested tiebacks do not meet the specified criteria for acceptance as determined by the Engineer or Authority.

PART 3 - EXECUTION

3.1 GENERAL

A. Install and remove excavation support systems in accordance with the accepted working drawings. Install, maintain, and remove excavation support system in such a manner as to prevent movement, settlement, or loss of ground, removal of fines from the adjacent ground, or damage to or movement of adjacent structures.

B. Borings and site history indicate below-ground obstructions may be encountered. Such obstructions may include, but are not necessarily limited to, boulders, granite blocks, and retaining walls from past structures, granite block walls, and various other demolition and construction debris. The Contractor is responsible for removal of obstructions by pre-trenching/pre excavation or other means and backfilling with a suitable material.

C. Protection of Existing Adjacent Structures

1. The Contractor shall repair all damage to adjacent properties and restore the surfaces and finishes to the original state.

2. If in the opinion of the Engineer the integrity of the adjacent railroad tracks, buildings, structures, or paved areas are jeopardized due to movement, the Contractor shall immediately discontinue further excavation in the affected area and implement a Plan of Action to mitigate further movement. Mitigating measures shall remain in effect until such time that the Engineer evaluates the impact on the structure and may direct the Contractor to perform any remedial work. The Contractor shall submit proposed remedial measures to the Geotechnical Engineer for review and approval. Submittals shall include methods and names of subcontractors. The Contractor shall proceed with remedial work upon acceptance by the Engineer. Mitigating measures shall be at no additional cost to the MBTA.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Engineer and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces is not impeded.

D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.3 SOLDIER BEAMS AND LAGGING

A. Install steel soldier beams before starting excavation. Space soldier beams at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wales horizontally at spacings indicated on the approved shop drawings and secure to soldier beams.

3.4 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment. Cut tops of sheet piling to uniform elevation at top of excavation.

3.5 TIEBACKS

A. Tiebacks shall be designed and installed by the Contractor in accordance with the current edition of the "Recommendations for Prestressed Rock and Soil Anchors", by the Post Tensioning Institute.

B. Excavation support wall, and other support system members incorporated in a system using tiebacks, shall be designed to resist the vertical components of the tieback loads without settlement during any stage of the excavation and construction.

C. Coordinate locations of all bracing and components thereof for temporary lateral excavation support with locations of permanent steel and foundation wall elements.

D. Install tiebacks in accordance with reviewed shop drawings as specified herein and as indicated on the Drawings.

E. Tiebacks shall be installed through sleeves or holes provided in the earth support system. Prevent loss of ground and water seepage at the tieback locations. Implement remedial measures immediately if loss of ground or seepage occurs at these locations.

F. Tiebacks shall be installed by duplex drilling methods only, using internal flushing methods only which provide return of wash fluid and cuttings through the inside of the outer casing. Outer casing shall be extended for the entire tieback length. Methods of installation shall be used which prevent the loss of ground, e.g. collapsing hole.

G. Tiebacks shall be installed with pressure grouted anchor zones of the regroutable type. Regroutable type tiebacks shall have the capability, following initial low pressure grouting, for regrouting in successive stages, using higher grouting pressures to increase load capacity. Each tieback must be capable of being retensioned, if necessary.

H. Each tieback installed for support of earth excavations shall be tested to verify and establish the tieback capacity. All testing shall be performed in the presence of the Engineer or Authority.

Performance tests shall be performed on a minimum of 10 percent of tiebacks for each design, as selected by the Engineer or Authority, to verify the tieback design. Tiebacks grouted into differing strata will be considered a different design. All other tiebacks shall be proof tested.

I. Performance Tests shall be conducted in accordance with procedures described in the current edition of the "Recommendations for Prestressed Rock and Soil Anchors", by the Post Tensioning Institute.

J. Proof Tests shall be conducted in accordance with procedures described in the current edition of the "Recommendations for Prestressed Rock and Soil Anchors", by the Post-¬Tensioning Institute.

K. Tiebacks shall be locked-off at a load equal to 75% of the tieback design load.

L. Acceptance of Performance tests and proof tests shall be determined by the Engineer in accordance with the current edition of the "Recommendations for Prestressed Rock and Soil Anchors", by the Post Tensioning Institute.

M. Any tieback which cannot meet the criteria for acceptance for its design capacity can only be incorporated in the bracing system using 67 percent of the load that can be maintained and meets the criteria for acceptance. Regroutable anchors will be accepted at full capacity after regrouting and acceptable proof testing.

N. Additional tests shall be performed when any changes are made in the tieback assembly or installation procedures at no additional cost to the Authority.

O. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

P. Inspect tiebacks periodically to confirm anchors exhibit no movement.

Q. Detension temporary tiebacks in accordance with the proposed construction sequence as accepted by the Authority.

3.6 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work, unless otherwise approved by Engineer.

2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.

3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.7 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.

1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon remainder. Repair or replace, as approved by Engineer, adjacent work damaged or displaced by removing excavation support and protection systems.

3.8 MONITORING OF EXCAVATION

A. The Contractor shall monitor the performance of components of the excavation support system, both for vertical and horizontal movement, at intervals specified below. If the Response Values as specified in Table 02260-1 attached are reached at any time during the work, the Contractor shall immediately stop work and implement approved contingency plans.

B. Possible effects of the excavation on the lateral support system:

1. Deflection of the wall into the excavation due to soil, groundwater, and surcharge loads.

2. Settlement adjacent to the lateral support wall due to inward deflection of the wall.

3. Settlement adjacent to the lateral support wall due to ground loss into the excavation through gaps and voids in the wall.

C. Monitoring Deflection of Wall

1. Once the wall is installed to final elevation but before excavation begins, establish deformation-monitoring points on the top of the wall, spaced approximately every 20 feet along the wall or at every other soldier pile, whichever is lesser. The monitoring points shall consist of markings which are clearly identifiable, and will produce a repeatable accuracy of within 1/8 inch in any direction.

2. Perform a baseline survey of each deformation monitoring point before excavation begins. Survey both vertical and lateral (into proposed excavation) position.

3. Perform daily survey of each top-of-wall deformation monitoring point from when excavation begins until full excavation depth is reached adjacent to the wall. Thereafter, perform weekly survey of monitoring points until the wall is backfilled.

4. When excavation reaches mid-depth, establish monitoring points on the face of the wall for lateral deflection monitoring. Perform a baseline survey of each point prior to additional excavation. Perform daily survey of each mid-wall deformation monitoring point until full excavation depth is reached adjacent to the wall. Thereafter, perform weekly survey of monitoring points until the wall is backfilled and concrete facing is constructed.

D. Monitoring Track Movement

1. Before the start of excavation and wall installation, establish elevations along Top of Rail of outbound track spaced approximately every 20 feet along the walls.

2. Perform two baseline elevation surveys of the Top of Rail before the start of excavation/wall installation. Survey both vertical and lateral (into excavation) positions.

3. Perform daily survey of settlement monitoring points from the beginning of excavation work until the track support structure is completed.

4. Perform weekly survey following completion of the track support structure until all work for the access structure completed including all concrete work, backfill and compaction. Landscaping work shall not be considered an outstanding work item.

5. Any existing structures supporting tracks or embankments adjacent to tracks in the vicinity of work, such as bridges, abutments, retaining walls, or other structures where settlement, deflection, or failure could affect the tracks shall be included in any monitoring program.

E. Survey instruments used for vertical deformation monitoring shall have a minimum accuracy of ±0.05 in and a minimum setting accuracy of ±1.0 arc seconds. Leveling staffs shall be non-telescopic in design (i.e. 'Chicago' style leveling staff). A bull's eye bubble shall be used to plumb the leveling rod.

F. Survey instruments used for horizontal deformation monitoring shall have a minimum accuracy of ± 3.0 arc seconds and a minimum display reading less than or equal to the accuracy. Distances less than 30 feet shall be measured with a standardized steel tape used in conjunction with a tension handle. Distances greater than 30 feet shall be measured with an Electro-Optical Distance Measuring Instrument (EDM). Distances between 30 and 100 feet shall be verified with a standardized steel tape in conjunction with a tension handle. Electronic pointing shall be used to minimize error due to possible misalignment of the EDM axis and telescope. Centering shall be accomplished using high precision optical plummets or mechanical centering devices.

G. EDM equipment used for lateral deformation monitoring shall, after calibration, have a minimum accuracy of ± 0.02 in plus 5 parts per million

H. Make adjustments to survey schedule and monitoring point locations (including the addition of monitoring points) as requested by the Engineer if additional monitoring of wall performance is desired. Extra monitoring points and increases in survey frequency shall be considered incidental to the costs associated with this Section.

I. The Contractor shall submit the results of the settlement point readings to the Engineer in draft form at the end of each working day. All monitoring data shall be reported to the Authority and Engineer within twenty-four (24) hours of measurement in tabular format, allowing comparison of current data to previous data, including baseline, and showing a complete history of movement versus time.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Separate measurement and payment will not be made for all work required under this Section complete in place, but all costs in connection therefore will be considered included in the Contract Lump Sum prices as identified below.

4.2 PAYMENT

A. Payment for support of excavation for construction at South Acton Station will be made at the Contract Lump Sum Price bid for Item 0221.418 – Support of Excavation.

B. Payment for support of excavation for construction at the Assabet River Bridge (MP 21.76) will be made at the Contract Lump Sum Price bid for Item 0221.419 – Support of Excavation – Bridge No. 1.

C. Payment for support of excavation for construction at the West Acton Bridge (MP 27.46) will be made at the Contract Lump Sum Price bid for Item 0221.420 – Support of Excavation – Bridge No. 2.

D. Payment for support of excavation for construction at the Mill Pond Bridge (MP 40.01) will be made at the Contract Lump Sum Price bid for Item 0221.421 – Support of Excavation – Bridge No. 3.

E. Payment for support of excavation for construction at the Baker's Brook Bridge (MP 47.84) will be made at the Contract Lump Sum Price bid for Item 0221.422 – Support of Excavation – Bridge No. 4.

F. Payment for support of excavation for construction at the Clematis Brook Culvert (MP 8.65) will be made at the Contract Lump Sum Price bid for Item 0221.423 – Support of Excavation – Bridge No. 5.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0221.418	SUPPORT OF EXCAVATION	LS
0221.419	SUPPORT OF EXCAVATION – BRIDGE NO. 1	LS
0221.420	SUPPORT OF EXCAVATION – BRIDGE NO. 2	LS
0221.421	SUPPORT OF EXCAVATION – BRIDGE NO. 3	LS
0221.422	SUPPORT OF EXCAVATION – BRIDGE NO. 4	LS
0221.423	SUPPORT OF EXCAVATION – BRIDGE NO. 5	LS

Attachment: Table 02260-1

TABLE 02260-1
RESPONSE VALUES

Monitoring Type	Value
Lateral Deflection of Earth Support Wall	
Top of wall	2.0 inches
Mid-point of wall	0.75 inches
Vertical Deflection of Earth Support Wall	
Top of wall	0.5 inches
Ground Surface Settlement	
Top of Rail	1/4 inch

END OF SECTION

SECTION 02270

SLOPE PROTECTION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. This Section specifies the following types of slope protection:

1. Type 1, Dumped Riprap: angular shaped stones dumped in place to form a well-graded mass with a minimum of voids.
2. Provision of an Erosion Control Mat over slopes steeper than 2H: IV as shown on the Contract Drawings or as directed by the Engineer. Prior to placement of erosion control mats, the slopes shall be covered with topsoil and seeded with Crown Vetch as specified within.

B. Related work described elsewhere:

1. Section 02100, SITE PREPARATION
2. Section 02300, EARTHWORK
3. Section 02920, LAWNS

1.2 QUALITY CONTROL

A. Control of gradation of stone for Type 1 slope protection shall be by visual inspection. Provide at the construction site and at the quarry a mass of rock of at least five tons meeting the specified gradation. The sample at the construction site may be a part of the finished riprap covering. These samples will be used as a reference for judging the gradation of riprap supplied.

B. Each roll of fabric or erosion control mat shall be labeled or tagged to provide product identification sufficient for field identification, as well as inventory and quality control purposes Each roll of fabric shall be stored in a manner that will protect them from the elements. If stored outdoors, they shall be elevated and protected with a waterproof cover.

C. Erosion control mats shall be installed in accordance with the manufacturer's recommendations. Where manufacturer's recommendations conflict with details shown on the Contract Drawings, the more stringent, in the opinion of the Engineer, shall apply.

PART 2 - PRODUCTS

2.1 TYPE 1, DUMPED RIPRAP

A. Stone: hard, durable, angular in shape; resistant to weathering; free from overburden, spoil, shale, and organic materials; neither breadth nor thickness of a stone shall be less than one third its length.

B. Gradation:

1.

1. Weight of Stone Smaller than Given Size — Maximum Percent of Total Weight

Weight of Stone Smaller than Given Size	Maximum Percent of Total Weight
400 pounds	100
300 pounds	80
200 pounds	50

2. Maximum percent passing a two-inch sieve: 5 percent.

C. Additional Information (**BEING DEVELOPED).**

2.2 EROSION CONTROL MAT

A. Fibers used in the manufacture of the erosion control mat, and the threads used in joining the erosion control mat by sewing, shall consist of long-chain synthetic polymers, composed of at least 85% by weight polyolefins, polyesters, or polyamides. They shall be formed into a network such that the filaments or yarns retain dimensioned stability relative to each other, including selvedges. These materials shall conform to the following physical requirements:

Property	Method	Value
Thickness	ASTM D-1777	0.40 in. (min)
Resiliency	ASTM D-1777	80% (min)
Flexibility	ASTM D-1388	450 lb/in (maximum)
Porosity	Calculated	95%
Ground Cover Factor	Light Protection Test	65% (min)
Tensile Strength	ASTM D-1682	130 x 105 lb/ft (min)
Moisture Absorption	ASTM D-570	.01% (max)
Elongation	ASTM D-1682	-90 x 90 lb/ft
Ultraviolet Stability	ASTM D-4355	80% (min)

B. Erosion control mat rolls shall be furnished with suitable wrapping for protection against moisture, and extended ultraviolet exposure prior to placement. Each roll shall be labeled or tagged to provide product identification sufficient for inventory and quality control purposes. Rolls shall be stored in a manner which protects them from the elements. If stored outdoors, they shall be elevated and protected with a waterproof cover.

PART 3 - EXECUTION

3.1 TYPE 1, DUMPED RIPRAP

A. Place riprap on the prepared slope or area in such a manner as to produce a well-graded mass of stone with the minimum practicable percentage of voids and a minimum thickness of eighteen inches. Place stone to its full course thickness in one operation and in such a manner as to avoid displacing the underlying material. Placing of stone in layers or by dumping into chutes or by similar methods likely

to cause segregation will not be permitted. Place and arrange stones by hand or by mechanical equipment as necessary to produce a compact riprap protection in which all sizes of stones are placed in their proper proportions.

B. Place riprap in conjunction with the construction of the embankment with only sufficient lag in construction of the riprap protection to allow for proper construction of the embankment and to prevent mixture of embankment and riprap material. Maintain the elevation of the riprap within five feet of the elevation of the embankment during construction.

C. Additional Information **(BEING DEVELOPED).**

3.2 EROSION CONTROL MAT

A. Slope surfaces shall be final graded, stable firm and free of rock or other obstructions which would prevent the mat from lying in direct contact with the soil.

B. Spread 6 inches of topsoil over final grade and seed with Crown Vetch before installing erosion control mat. Low Maintenance Ground Cover, Crown Vetch Seed Mix: K-31 Tall Fescue at 40 pounds for each acre and Crown Vetch at 20 pounds for each acre. Inoculate seed with fresh inoculant as directed on package insuring that Crown Vetch inoculant contains sticker supplement. Maintain temperature of between 50 and 75 degrees F during inoculation. When hydroseeding, use 4 times inoculant rate.

C. Install the upslope folded mat end by burying in a 6 inch wide by 24 inch deep trench as shown on the Drawings. Staple the mat along the bottom of the trench at 1.5 foot intervals. Backfill the trench and firmly compact. Install a row of staples 1 foot downslope of the trench along the width of the fabric at 1.5 foot intervals.

D. Place 18-inch long anchoring pins over the slope area at 4 foot centers

E. Anchor the downslope end of the mat in a similar manner as specified for the upslope.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Type 1 Slope Protection (Riprap) will be measured by the square yard, complete in place.

B. Erosion control mats for slope stabilization will be measured by the number of square yards placed as shown on the Drawings or as ordered by the Engineer

4.2 PAYMENT

A. Type 1 Slope Protection (Riprap) will be paid for at the Contract unit price for the quantities as specified above.

B. The unit price bid for Slope Protection using Erosion Control Mat (per square yard) shall include the cost of furnishing all labor, materials, equipment, and incidentals necessary to satisfactorily complete the work.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0297.610	RIPRAP SLOPE PROTECTION	SY
0222.592	SLOPE PROTECTION	SY

END OF SECTION

SECTION 02282

HANDLING, TRANSPORTATION AND DISPOSAL OF EXCAVATED MATERIALS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies field screening, stockpiling, segregating, tracking, transporting, and disposing of excavated materials.

B. Related Work: The following items are not included in this Section and shall be performed under the designated Sections:

1. Section 01568 - CONSTRUCTION SAFETY
2. Section 02300 - EARTHWORK.

C. The Authority will be the generator and will sign all disposal facility waste profiles, Hazardous Waste Manifests (manifest) and 21E Bills of Lading (Bills of Lading) as the Generator. The Contractor's License Site Professional (LSP) shall sign all Bills of Lading as the LSP. Except for soil that requires transport under manifest, all soil shall be transported under Bills of Lading regardless of the chemical quality of the soil. All paperwork required for work under this Section shall be prepared by the Contractor.

D. Furnish all labor, materials, equipment, and incidentals necessary to properly excavate, segregate, handle, load, transport and dispose of excavated materials located within the Limit of Work. Work covered by this Section shall include furnishing, operating, and maintaining equipment decontamination stations for the duration of excavation activities and dismantling, disposing of decontamination stations at project completion. Decontamination stations shall be capable of eliminating the dispersion of dust and mud caused by vehicles exiting the site.

1.2 RESPONSIBILITIES

A. The Contractor shall employ the services of an Environmental Consultant to assist in the activities listed below. Contractor's Responsibilities:

1. The Contractor shall employ the services of an Environmental Consultant to perform the screening, sampling, BOL preparation, and help ensure compliance with all references listed in this Section. The Environmental Consultant shall include at least one Licensed Site Professional (LSP) registered with the Massachusetts LSP Board. Proof of current licensure shall be provided to the Engineer with the EMMP.
2. The Contractor shall field-screen excavated material for the presence of volatile organic compounds (VOCs) with a photoionization detector (PID). As directed by the Engineer, samples representative of each 20 cubic yards of material excavated shall be screened.
3. The Contractor shall be responsible for the submitting to the Engineer the daily logs summarizing field screening and excavating activities.
4. The Contractor shall identify and propose temporary storage facilities, landfills, soil recycling and hazardous waste treatment, storage and disposal facilities for all excavated material.

5. The Contractor shall be responsible for transporting excavated material to the approved temporary storage facility, landfill, soil recycling and/or hazardous waste treatment, storage and/or disposal facility.
6. The Contractor shall furnish, operate and maintain equipment decontamination stations for the duration of excavation and soil disposal work.
7. The Contractor shall develop and implement site-specific emergency response and health and safety protocols and procedures.
8. For each shipment of material transported to a disposal facility, the Contractor shall demonstrate to the Engineer that he has selected the least costly means of disposal. This demonstration shall be made prior to shipment.
9. The Contractor shall be responsible for submitting completed Bills of Lading, manifests and other shipping documents to the Engineer within two weeks of shipment to a storage or disposal/recycling facility. The Contractor's LSP shall sign and stamp Bills of Lading.
10. The Contractor shall advise the Engineer and Consultant at least three working days in advance of the schedule for off-site disposal of excavated material.
11. The Contractor shall collect, analyze and characterize samples of excavated material prior to off-site recycling and/or disposal.
12. The Contractor shall prepare the necessary documents to transport and dispose of excavated material. These documents include, but are not limited to waste profiles, Bills of Lading and manifests.
13. The Contractor shall submit the executed transportation and disposal documents to the appropriate local, state and federal agencies as well as the Engineer.
14. The Contractor shall provide an environmental field technician to oversee the loading of excavated material into transport vehicles for off-site disposal/recycling.
15. The Contractor shall keep records, including daily logs and photographs, of all waste streams, stockpiles, and excavated materials for the purposes of tracking points of origin.
16. The Contractor shall develop and implement dust control measures

B. Authority's Responsibilities:

1. The Authority will review submitted proposed facilities selection of off-site recycling, reuse or disposal facilities.
2. The Authority will be the designated Generator for excavated material identified for off-site reuse, recycling and/or disposal.
3. The Authority will review all submitted paperwork, manifests, and Bills of Lading.

1.3 QUALITY ASSURANCE QUALITY CONTROL

A. The Contractor shall be responsible for the collection and analysis of soil samples from all areas of the site by either in situ or ex situ sampling. Sampling frequency shall be conducted as to meet the requirements of the disposal facility. For the purpose of disposal, TPH data is acceptable. However, MCP notification shall be based upon VPH and/or EPH MADEP Method 1.0 analysis. The contractor shall include the result of all analysis in the Excavated Materials Management Plan.

1.4 SUBMITTALS

A. The Contractor shall include the following information in an Excavated Materials Management Plan (EMMP):

1. A schedule detailing the proposed sequence of work.

2. The Contractor shall develop the procedures for field screening, laboratory testing, or other monitoring of excavated material generated during construction and/or site preparation, as required by regulations.

3. All pertinent information relating to the transport of excavated material. The information, at a minimum, shall include:
   a. Name and address of all transporters.
   b. Transporter identification number (USEPA or Massachusetts Department of Transportation Transporter) and expiration date.
   c. Proof of permit, license, or authorization to transport excavated material in all affected states.
   d. Details of containers to be used for transporting excavated material. Refer to Part 2 of this Section.
   e. Dust control measures

4. The Contractor shall identify each waste stream and propose an appropriate disposal facility that will accept the excavated material. The Contractor shall submit to the Engineer, approvals or letters of intent and facility information for each facility proposed, within 14 days of issuance of the Notice to Proceed. For each facility, the Contractor shall submit the following information:
   a. General Information
      1 Facility Name
      2 Facility Address
      3 Name of Contract Person
      4 Title of Contact Person
      5 Telephone Number of Contact Person
      6 Permit Number
   b. The facility shall specify the volume of material that can be accepted from the site on a weekly and a total basis.
   c. The facility shall provide written confirmation that they are permitted to accept and will accept the classified material of the general quality and quantity described by these Specifications.
   d. The facility shall provide a listing of all current and valid permits, licenses, letters of approval, and other authorizations to operate that they hold, pertaining to the receipt and management of the soils or materials specified in this contract.
   e. The Contractor shall submit a complete list of the disposal facility's permitted allowable contaminant levels and physical characteristic requirements for excavated material, and list any required regulatory approvals for individual waste streams.

5. Location, name, address and pertinent information for any proposed off-site temporary storage location.

B. Laboratory results for all samples collected and/or analyzed by the Contractor shall be tabulated and compared to applicable MCP standards by the Contractor's Environmental Consultant and subsequently submitted to the Engineer within two days of receipt. The results shall include all Chain-of-Custody forms and all documentation provided by the laboratory.

1.5 REFERENCES

A. All regulations cited and those of other governing agencies in their most recent version are applicable. This Section refers to many requirements found in these references, but in no way is intended to cite or reiterate all provisions therein or elsewhere. It is the Contractor's responsibility to know, understand,

and abide by all such regulations and common practices. Other provisions contained in these references may from time to time during the execution of this Contract be enforced by the Authority or the Engineer. In the event of a conflict, the most stringent regulations shall govern. The following documents and/or publications are made part of this Section by reference herein:

1. Massachusetts Contingency Plan (MCP), 310 CMR 40.0000.

2. Massachusetts Hazardous Waste Regulations, 310 CMR 30.00.

3. Solid Waste Management Facility Regulations, 310 CMR 19.00.

4. Site Assignment Regulation for Solid Waste Facilities, 310 CMR 16.000.

5. Interim Remediation Waste Management Policy for Petroleum Contaminated Soils, DEP Bureau of Waste Site Cleanup Policy No. WSC-94-400.

6. "Reuse and Disposal of Contaminated Soils at Landfills", DEP Bureau of Waste Prevention Interim Policy No. BWP-94-037.

7. "Hazardous Waste Operations and Emergency Response", Federal Occupational Safety and Health Act (OSHA), 29 CFR 1910.120.

8. "General Regulations for Hazardous Waste Management", EPA, 40 CFR 260.

9. "Regulations for Identifying Hazardous Waste, Hazardous Waste Generators and Hazardous Waste Transporters", EPA, 40 CFR 261, 262 and 263.

10. "Standards for Management of Specific Hazardous Wastes and Facilities", EPA, 40 CFR 266.

11. "Construction of Buildings in Contaminated Areas," DEP, Bureau of Waste Site Cleanup Policy #WSC-00-425, dated January 2000.

12. Massachusetts DEP Policy #COMM-97-001.

13. Local regulations governing dust control, soil handling, and health & safety (see Section 01567 – HEALTH AND SAFETY).

1.6 DEFINITIONS

A. Excavated Material: All soil and/or debris excavated from within the Limit of Work.

B. Waste: Any excavated material found to not be suitable for on-site reuse based on visual or olfactory observations, field screening data, or geotechnical suitability.

C. Surplus: Any excavated material found to be suitable for on-site reuse based on visual or olfactory observations, field screening data, or geotechnical suitability.

D. Contaminated Material: Any excavated material found to contain contaminant concentrations in excess of the Massachusetts Contingency Plan category S-1 Method 1 Standards or S-1 Reportable Concentrations whichever is lower...

E. Generator: Any person whose actions or process produces a material that is subject to regulation(s).

F. Hazardous Material: include but is not limited to Asbestos, and materials regulated under TSCA, M.G.L., chapter 21E, RCRA (310CMR 30.00) and the MCP (310 CMR 40.00). Where applicable consideration should be given to MSDS in determining if a material could be potentially hazardous

1.7 PERMIT REQUIREMENTS

A. The Contractor shall obtain all Federal, State, and local permits required for the transport and disposal of excavated material. The Contractor shall adhere to all permit requirements.

B. The Contractor shall document that the disposal facilities proposed have all certifications and permits as required by Federal, State, and local regulatory agencies to receive and dispose of the excavated material.

PART 2 - PRODUCTS

2.1 GENERAL

A. All Contractor personnel shall wear personal protective equipment and protective clothing consistent with the levels of protection for this Work as indicated in Section 01567 – HEALTH AND SAFETY.

B. Containers used for hauling the excavated material shall be constructed of steel, in good condition and designed for the intended purpose of safe, secure storage of hazardous material during loading and transport to an approved facility. The containers shall have a secure cover that prevents a release of material from truck during transportation. The container and covers shall be approved by the Engineer prior to mobilization of trucks/containers. The containers must be approved by and labeled in accordance with the US Department of Transportation (DOT). The containers shall be sift proof and water resistant in accordance with the DOT regulations.

2.2 STORAGE LABELS

A. Provide signage to label all stockpiles. Labels shall be of 6-inch by 12-inch weatherproof material, such as plastic, affixed to 1" x 3" wood straps, 3 feet long. The labels shall be clearly marked with indelible ink marker. Markings shall be as agreed upon between Authority and Contractor.

2.3 STOCKPILE SHEETING

A. Stockpile Sheeting: Provide Nylon-reinforced polyethylene (NRPE) sheeting as follows:

1. The membrane shall be manufactured of new, first quality product designed and manufactured specifically for the intended use.

2. The material shall be 10-mil polyethylene reinforced with a non-woven grid of high strength nylon cord.

3. The material shall be ultra-violet resistant and cold crack resistant to -40 degrees F.

4. The materials shall be manufactured in a minimum 12 foot seamless width. Labels on the roll shall identify the thickness, length width and manufacturer's mark number.

2.4 EQUIPMENT AND VEHICLE DECONTAMINATION PAD

A. A decontamination pad shall be constructed of reinforced concrete or bituminous concrete to withstand an H-20 loading. The decontamination pad shall be of minimum length to accommodate one 18-wheel dump truck, and a minimum area to accommodate the largest piece of equipment to be used in the excavation. The pad shall have a six inch containment berm and provisions for collection, storage and disposal of decontamination water.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall handle and convey all materials to perform site work described in this Contract.

B. The Contractor shall perform any additional disposal characterization sampling and analytical testing of the excavated material as required by the permitted disposal facility at no additional cost to the Authority.

C. Based upon all analytical results, transport and dispose of the excavated material as specified herein.

D. An LSP Opinion shall be required for all material shipped using a Massachusetts Bill of Lading.

E. Utilization of a Hazardous Waste Manifest shall require the use of a licensed hazardous material transporter in conformance with the Massachusetts Hazardous Material Regulations as required by 310 CMR 30.0000. An LSP Opinion is not required when using a Hazardous Waste Manifest for transporting excavated materials.

F. The Authority shall have final approval over all disposal options.

G. Immediately notify the Authority of visible stains or unnatural odor of any excavated material, or if potentially contaminated and/or hazardous material is encountered.

3.2 FIELD SCREENING EXCAVATED MATERIAL

A. Screen excavated materials for the presence of oil and hazardous materials as excavation proceeds using visual, olfactory and field screening evaluation.

B. Perform field screening evaluation in accordance with Department of Environmental Protection Policy No. WSC-94-900, "Interim Remediation Waste Management Policy for Petroleum Contaminated Soils, Attachment II, Jar Headspace Analytical Screening Procedure."

C. Provide services of one or more individuals to field screen excavated materials. The individual(s) shall have been adequately trained in the use of the PID. Jar headspace results shall be recorded on the Contractors daily excavation log.

D. Field screening equipment shall be provided by the Contractor and maintained and calibrated according to the manufacturer's recommendations.

E. Maintenance and calibration data shall be recorded on the Contractor's daily excavation log and submitted to the Consultant.

F. The Contractor shall perform field screening of excavated material at a frequency no less than every 20 cubic yards of material or fraction thereof.

G. The Contractor shall conduct TCLP testing for soil contamination that is 20 times the Hazardous Waste Threshold concentration (310 CMR 30.125B).

H. The Contractor shall use the following field screening classification system in order to segregate excavated material:

FIELD SCREENING CLASSIFICATION SYSTEM

MEDIA	VISUAL/ODOR	JAR HEADSPACE ANALYSIS	SCREENING CLASSIFICATION
Material	Light or No Staining	<10 ppm	Presumed Reusable/Surplus
Material	Staining/Odor or Unnatural Colors	>10 ppm	Presumed Waste

I. In the event that reportable conditions are encountered which require notification to the Department of Environmental Protection (DEP), the requirements of the MCP shall apply. Depending upon the nature of the reportable conditions, the MCP may require the cessation of Work, implementing an "Immediate Response Action Plan", or developing a "Release Abatement Measures Plan" prior to continuing work, or other actions, which could delay certain aspects of site Work. The Contractor shall ensure that his field supervisory personnel are familiar with the MCP definitions of "two hour", "72 hour" and "120 day" reportable conditions. The Contractor shall immediately notify the Authority's on-site resident representative of any 2-hour and 72-hour reporting conditions. Notification to the DEP shall be the sole responsibility of the Authority. Please note that MCP notification, for petroleum identified by TPH analysis, shall be based upon VPH and/or EPH MADEP Method 1.0 analysis.

3.3 DISPOSAL CHARACTERIZATION SAMPLING

A. The Contractor shall be responsible for sampling and characterizing the excavated material for the purpose of obtaining approvals from the disposal facility (ies). The Contractor shall provide the Engineer with a minimum of 2 days notice prior to sampling and shall not sample unless Engineer's approval is received.

B. Samples shall be collected at a frequency of a minimum of one sample per 500 cubic yards of material to be excavated during construction activities. Should the Contractor's disposal facilities require additional samples, the Contractor shall collect a sufficient number of samples to satisfy the requirements of the disposal facility. No separate payment will be made for sampling conducted by the Contractor or the Contractor's LSP for the purposes of disposal characterization.

1. The collected samples shall be submitted, at a minimum, for the following chemical analyses: total petroleum hydrocarbons (TPH) using modified EPA Method 8100, acid/base/neutrals (A/B/Ns) using EPA Method 8270, volatile organic compounds (VOCs) using EPA Method 8260, polychlorinated biphenyls using EPA Method 8081, RCRA 8 metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver) using Method 6010/7471, reactive cyanide and sulfide using EPA Method SW-846, Ignitability using modified EPA Method 1010, Corrosivity using EPA Method 9045, and Conductivity using EPA Method 120.1. Any samples found to contain contaminant concentrations equal to or greater than "20 times" their hazardous

waste toxicity threshold (i.e., the 20-times rule) shall be analyzed for toxicity characteristic leachate procedure (TCLP).

C. Submit a copy of all chemical analyses and a tabulated summary of the data to the Engineer within 2 days of receipt of the laboratory report.

D. Take samples in such a manner as not to cause any cross-contamination. All sampling equipment shall be decontaminated between usages.

E. All analyses shall be performed by a laboratory certified for such analyses by the Commonwealth of Massachusetts.

F. The Engineer may stop the Contractor's work in a particular location at any time in order to have samples taken and analyzed. If necessary, the Contractor shall assist the Engineer in collecting samples. The work shall not resume in that area until directed by the Engineer. Stoppage of work for this reason, or until laboratory results are delivered to the Engineer, shall not be a cause for the Contractor to request additional compensation or an extension of time to the Contract or to other intermediate Contract deadlines.

G. The Contractor shall not backfill an excavation until the Engineer has given approval to do so. The Contractor shall expect at least a three day period for time to confirm that the appropriate limits of excavation has been completed.

3.4 TEMPORARY STOCKPILING OF EXCAVATED MATERIALS

A. All excavated material shall be stored in a secure manner to prevent exposure to humans and the environment.

B. The stockpiling or consolidating of excavated material near sensitive human health receptors such as public and private water supply wells or sensitive environmental receptors such as wetlands, surface water bodies, or marine environments shall be prohibited.

C. All excavated material stored at the site of generation or at a temporary storage location shall be placed entirely on a polyethylene liner, and shall be covered at the end of each day's work with the same material or so as to minimize the infiltration of precipitation, volatilization of contaminants and erosion of the stockpile. Any cover material used shall be properly secured and possess the necessary physical strength to resist tearing by the wind and other elements.

D. The stockpiles shall be bermed around the edges to minimize infiltration of storm water or exfiltration of leachate.

E. Any failure of materials or procedures used in employing the base layer or cover layer shall be immediately repaired, replaced or re-secured so as to minimize precipitation infiltration, volatilization and erosion/runoff of the excavated material.

F. Movement and/or aeration of excavated material shall be limited to those activities that are necessary to manage such stockpiles. Land farming of material stockpiles is prohibited.

G. Excavated material not previously classified in accordance with the field screening classification, final characterization, or as otherwise directed by the Authority shall be stockpiled separately based on classification. Transfer suspected waste material from the excavation to a stockpile area in a manner to prevent the spread of contaminated material with other materials.

H. Disposal of material that is contaminated as a result of careless handling or use of unauthorized procedures shall be at the Contractors expense. Delays of Work resulting from temporary storage of excavated material, regardless of the classification, shall be at no additional cost to the Authority.

I. Excavated material shall be reused on site or disposed off site within 120 days of excavation.

J. The Contractor shall segregate excavated material into stockpiles no greater than 500 cubic yards. The Contractor shall collect the necessary samples of the stockpile at that time for classification.

K. The stockpiles shall be clearly labeled and securely barricaded from contact with workers and the general public.

3.5 TRACKING OF EXCAVATED MATERIAL

A. The Contractor shall provide a soil tracking system to track soils between excavation, stockpiling, sampling and testing and final disposition.

1. Include in the soil tracking system the identification of the source of material (i.e. station, offset), depth, date of excavation and stockpile identification and location.

2. Submit to the Authority for review the soil tracking plan. This plan shall include all proposed daily log sheets

3. Provide to the Authority, on a daily basis, copies of field records documenting the location of stockpiled material in the system and stockpile identification data.

4. Each stockpile shall be identified with a suitable weatherproof sign attached to a stake driven into each pile.

5. Employ a master plan of the soil stockpile area(s), and mark and maintain the plan to show the location of all soil stockpiled on a daily basis. Furnish a duplicate copy of the master stockpile plan to be located in the Consultant's field office and updated on a daily basis.

3.6 DEBRIS DECONTAMINATION

A. As required by designated disposal facilities, the Contractor shall be responsible for decontaminating any debris shown to be contaminated by sampling at no additional cost to the Authority. The decontamination means and methods shall be included in the EMMP submitted to the Engineer 14 days after issuance of Notice to Proceed.

3.7 ON-SITE AND OFF-SITE REUSE CATEGORIES

A. Excavated material found to be suitable for on-site or off-site reuse shall conform to the following:

1. Excavated material found to contain contaminant concentrations less than MCP reportable concentrations, category S-1 or category S-1 Method 1 standards (whichever is lower), is suitable for all on-site reuse and off-site reuse at urban or commercial locations. The Contractor's LSP shall be responsible for documenting that excavated material that is designated for on-site or off-site reuse shall contain contaminant concentrations equal to or less than the contaminant concentrations at the designated reuse location (in accordance with the

MCP's "anti-degradation" policy). The Engineer shall have final approval over all proposed reuse locations.

2. Excavated material found to contain contaminants above category S-1 MCP RCs and/or "urban fill", such as bricks, ash, concrete, glass, metal, or other non-native materials shall be reused on site to the maximum extent possible. The Contractor's LSP shall be responsible for documenting that excavated material that is designated for on-site shall contain contaminant concentrations equal to or less than the contaminant concentrations at the designated reuse location (in accordance with the MCP's "anti-degradation" policy). The Engineer shall have final approval over all proposed reuse locations. The Contractor shall be responsible for any sampling and analyses required to comply with these requirements at no additional cost to the Authority.

3.8 DISPOSAL FACILITY CATEGORIES

A. The Contractor shall transport the material for off-site reuse, recycling, or disposal at a permitted facility based on the following categories:

1. In-State Landfill Material: Excavated material that meets DEP criteria for reuse at in-state landfills, to be used as daily cover, intermediate cover, and pre-cap contouring material. The material must not exceed the contaminant levels listed in DEP Policy #COMM-97-001. This category also includes excavated material and solid waste that meets Massachusetts DEP Solid Waste criteria and regulations and the facility's operating permit for reuse or disposal in the Massachusetts landfill.

2. Non-RCRA Out-of-State Lined Landfill Material: Excavated material that meets the destination state's solid and hazardous waste regulations and the receiving facility's operating permit(s). This includes material shipped for reuse as daily cover, intermediate cover, and pre-cap contouring material or material shipped for disposal. This also includes material designated as a "special solid waste".

3. In-State Recycling Facility Material: Excavated material that meets the criteria set forth in DEP Policy WSC-94-400 and the receiving facility's operating permit(s) for recycling at a licensed in-state facility.

4. RCRA Landfill Material: Excavated material that contains contaminant concentrations that exceed the criteria and standards listed above, or contain a listed or characteristic hazardous waste according to the state and federal regulations listed in Part 1 "References" Article of this Section.

B. Material shall be transported using a Bill of Lading; except RCRA Landfill Material shall be transported under a Uniform Hazardous Waste Manifest.

C. Material shipped to any recycling/disposal facility must meet the selected facility's chemical and physical acceptance criteria. Selected facilities must be established, fully operational, appropriately insured, and be operating in compliance with all applicable local, state, and federal regulations.

3.9 WEIGHT AND MEASUREMENT

A. The Contractor shall provide certified tare and gross weight slips for each load received at the accepted Facility and these shall be attached to each returned manifest or Bill of Lading.

3.10 WASTE PROFILES AND MANIFESTS

A. The Contractor shall prepare and submit to the Engineer for review all waste profile applications and questionnaires, and coordinate with disposal facilities and all Federal and State Environmental Agencies.

B. The Contractor shall prepare all Hazardous Waste Manifests, Bills of Lading, and material shipping records with all applicable analytical backup, notification, and control forms. Final copies of Bills of Lading shall be signed by the Authority as generator and by the Contractor's LSP following submissions and approvals of draft Bills of Lading.

C. The Contractor shall also provide certified tare and gross weight slips for each load received at the designated facility which shall be attached to each returned manifest.

D. The Contractor shall furnish all generator copies of the Hazardous Waste Manifest to the Authority for submittal to the appropriate regulatory agencies and to retain for the Authority's records.

E. The Contractor shall submit to the Engineer, prior to receiving progress payment, documentation certifying that all materials were transported to, accepted, and disposed of, at the selected disposal facility. The documentation shall include the following, as a minimum.

1. Documentation shall be provided for each load from the site to the disposal facility, including all manifests and any other transfer documentation as applicable.

2. All documentation for each load shall be tracked by the original manifest document number that was assigned by the Engineer at the site.

3. All ORIGINAL signatures (including signatures of Authority and disposal facility's representative) associated with shipment of any material from the site under a Bill of Lading.

3.11 TRANSPORT OF EXCAVATED MATERIAL

A. The Contractor shall not be permitted to transport materials off-site until all storage, disposal, or recycling facility documentation has been received, reviewed, and approved by the Engineer.

B. The Contractor shall transport materials from the site to the storage, disposal, reuse of recycling facility in accordance with all United State Department of Transportation (DOT), USEPA, MADEP, and applicable state and local regulations.

C. The Hauler(s) shall be licensed in all states affected by transport.

D. The Contractor shall be responsible for ensuring that free liquid is properly transported. "Wet soils" shall not be loaded for transport. The Contractor shall dewater "wet soils", and properly dispose of free liquid in accordance with local, state, and federal regulations. The Contractor shall dispose of any free liquids that may results during transportation at no additional cost to the Authority.

E. All excavated material transported upon public roadways shall be covered to minimize fugitive dust, and where necessary truck tire and undercarriage decontamination shall be employed to minimize tracking of soils onto public roadways.

3.12 DISPOSAL

A. Dispose of excavated materials at an approved facility in accordance with all federal, state and local regulations.

B. The Contractor shall perform analyses on the material as necessary to fulfill any disposal testing requirements of the approved Facility.

1. The Contractor shall bear all costs incurred in sampling and analyses for those tests required by the facility in excess of those performed by the Engineer.

2. The Contractor shall submit a copy of all sampling analyses to the Engineer within two days of receipt of the laboratory report. Analytical data shall be kept confidential, distributed to the Engineer only.

C. The Contractor shall provide to the Engineer copies of all weight slips; both tare and gross, for every load weighed and disposed of at the approved facility. The slips shall be tracked by the original manifest document number that was assigned by the Engineer at the site. The Engineer shall make progress payments after receipt of these weight slips.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Disposal of materials either not suitable or not needed shall be measured by the ton of material taken off site for each facility. Measurement shall be made for each classification as identified in the payment item list. The contract unit prices shall include all costs associated with stockpiling and disposal, including material handling, maintaining the stockpile area, stockpile sheeting, straw bales, drums, fencing, signage, LSP services, and all costs associated with chemical testing required to characterize the material for acceptance by the proposed facilities.

B. Measurement for REMOVAL AND DISPOSAL OF excavated materials suitable for reuse as daily cover, intermediate cover, contouring material, or disposal at IN-STATE LANDFILLS shall be by the ton as accepted by the facility. Payment will be made upon Authority's confirmation of the accepting facility's weight receipts and executed transportation and disposal documentation.

C. Measurement for REMOVAL AND DISPOSAL OF excavated materials suitable for disposal at IN-STATE RECYCLING FACILITIES shall be by the ton as accepted by the facility. Payment will be made upon Authority's confirmation of the accepting facility's weight receipts and executed transportation and disposal documentation.

D. Measurement for REMOVAL AND DISPOSAL OF excavated materials suitable for disposal at NON-RCRA OUT-OF-STATE LINED LANDFILLS shall be by the ton as accepted by the facility. Payment will be made upon Authority's confirmation of the accepting facility's weight receipts and executed transportation and disposal documentation.

E. Measurement for REMOVAL AND DISPOSAL OF excavated materials suitable for disposal at IN-STATE UNLINED LANDFILLS shall be by the ton as accepted by the facility. Payment will be made upon Authority's confirmation of the accepting facility's weight receipts and executed transportation and disposal documentation.

F. Measurement for REMOVAL AND DISPOSAL OF excavated materials suitable for disposal RCRA LANDFILLS shall be by the ton as accepted by the facility. Payment will be made upon Authority's confirmation of the accepting facility's weight receipts and executed transportation and disposal documentation.

G. No separate measurement or payment will be made for determining suitability of materials for on-site usage. All costs associated with such sampling and testing shall be considered incidental to the work for which the soil is used.

H. No separate measurement or payment shall be made for the on-site or off-site reuse of excavated, surplus, or waste material, including all sampling, analyses, loading transporting, and unloading activities related hereto.

I. No separate measurement or payment will be made for construction, operation, or demolition of the decontamination station, including disposal of accumulated solids and water. This work shall be considered incidental to the work of this Section.

4.2 PAYMENT

A. Payment for excavated materials management will be at the contract unit price for the quantities determined as specified above.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0221.345	DISPOSE OF CONTAMINATED SOIL AT IN-STATE LINED LANDFILL	TN
0221.346	DISPOSE OF CONTAMINATED SOIL AT OUT-OF-STATE LINED LANDFILL	TN
0221.347	DISPOSE OF CONTAMINATED SOIL AT IN-STATE RECYCLING FACILITY	TN
0221.349	CONTAMINATED SOIL DISPOSAL AT NON-RCRA OUT-OF-STATE LANDFILL	TN
0221.353	DISPOSE OF SOIL AT IN-STATE UNLINED LANDFILL	TN
0222.346	DISPOSE OF RCRA HAZARDOUS WASTE	TN

END OF SECTION

SECTION 02296

TRAFFIC DECKING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies designing, furnishing, installing, maintaining and removing decking of streets and sidewalks required for maintenance of traffic over excavated areas. Decking includes surface members and those supporting members upon which they directly rest.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 02360 - DRIVEN PILES.
2. Section 05100 - STRUCTURAL STEEL.

1.2 SUBMITTALS

A. Shop Drawings:

1. Show methods and sequence of installation and construction of decking and supporting members, including details of girders, beams, piles other than those forming a part of the excavation support system, accessories, surface materials, openings, ramps, guard rails, curbs, signs and access hatches.
2. Include engineering calculations supporting the design and selection of materials and methods stamped by a registered engineer.
3. Show methods and proposed sequence of removing decking and restoring the roadway.

1.3 QUALITY ASSURANCE

A. DESIGN CRITERIA: The Contractor shall be responsible for the design of decking. Comply with Contract Drawings and the following criteria.

1. Design for AASHTO HS20 loading, indicated earth pressures, utility loads and other applicable live and dead loads, including construction equipment.
2. Design structural steel in accordance with Section 05100.
3. Design decking to include the following:
   a. Wheel guards, railings, barricades and safety construction.
   b. Access hatches for utilities and for fire hydrants and valves.
   c. Clearance for existing and relocated utilities.
4. Select timber and lumber species and grade in accordance with ASTM D2555 to meet the design unit stresses.
5. Select anti-skid material of a type which, after installation, has a skid number at 30 mph or not less than 35 when tested in accordance with ASTM E274.
6. Maximum grade for vehicular ramps: five percent.
7. Maximum grade for pedestrian ramps: ten percent.

8. Provide minimum 12-inch high wheel guards of an accepted type securely installed around perimeter of openings in the decking.

1.4 PROJECT CONDITIONS

A. Ventilation. Provide ventilation as required to prevent the accumulation of gases below decking.

B. Illumination and Access. Provide illumination, galleries, walkways, and access facilities as necessary to enable inspection of the supporting system, lagging, bracing, and utilities maintained in place. Provide these facilities for the full length of decking where excavation is deeper than 20 feet. Provide suitable openings and flush covers for access to utility services located below the decking and for fire fighting access.

PART 2 - PRODUCTS

2.1 GENERAL

A. Decking materials may be either new or used. Used materials shall be sound and free of damage or defects, which would impair their suitability. Prior to installation of decking material the Engineer will inspect used material and may require that certain items of decking material be removed from the work.

B. Steel Plank: ASTM A 36, suitable for service, sized to limit deflection under full AASHTO H-20 and construction loading of 1/2 inch.

C. Wood and Timber Members: Suitable for service, sized to limit deflection under full AASHTO H-20 and construction loading of 1/2 inch.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Piling other than that forming a part of the excavation support system: Section 02360 - DRIVEN PILES.

B. Install decking in accordance with the approved Shop Drawings. Securely fasten surface members to prevent movement under traffic conditions. Bed transition members, plates and ramps to existing pavement in asphalt patching material to prevent movement and noise under traffic conditions.

C. Apply anti-skid material at ramps, vehicular traffic intersections, and on traffic lanes approaching traffic intersections and pedestrian crossings for a distance of 150 feet, in accordance with the manufacturer's instructions.

D. Install decking within plus or minus one inch of the elevations indicated on the approved Shop Drawings; except, install and maintain surface elevations at abutting elements within 1/2 inch of each other.

3.2 MAINTENANCE

A. Immediately replace or repair broken or chipped pieces, bent or loose plates and deck members and protruding fasteners. Patch adjacent paving as potholes develop, and immediately re-secure and bed loose transition members, plates and ramps to the existing pavement.

B. Replace anti-skid materials when its effectiveness is less than 70 percent of the specified values.

C. Maintain the surfaces of the decking, transitions and ramps in vehicular and pedestrian traffic lanes and intersections free of dirt, snow, and ice and other deleterious materials.

D. Maintain the decking in an acceptable condition at all times.

3.3 REMOVAL

A. When no longer required, remove the decking and all temporary supporting members and dispose of them off the job site.

B. Cut off interior support members at the elevation shown on the approved Shop Drawings.

C. Remove exterior support members either to a level ten feet below finish ground level or to the top of the adjacent Authority subway structures, whichever elevation is higher.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. No separate measurement will be made for work under this Section, but all costs in connection therewith shall be included in the items of work to which it pertains.

END OF SECTION

SECTION 02298

TEMPORARY PEDESTRIAN FACILITIES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. This section specifies requirements for furnishing, installing, operating and maintaining temporary pedestrian facilities.

B. Except for the materials shown on the Drawings to be left in place, all materials provided by the Contract under this section shall be removed by the Contractor when no longer required.

1.2 SUBMITTALS

A. Submit plans of temporary pedestrian facilities for each phase of construction at least 30 days prior to implementation of that portion of the Work.

1. Indicate construction zones, laydown areas, storage areas, location of construction field offices, and locations of temporary fence. Indicate access locations for each zone.
2. Indicate the temporary platform at the Railroad Street Trackside Parking Area with the dimensional and material requirements shown on the drawings.
3. Indicate the pedestrian at grade crossings of the inactive track at the existing platform area.
4. Indicate pedestrian routes and detours through and around each construction zone.
5. Indicate all existing and temporary crosswalks.
6. Indicate the extent and type of all proposed temporary pedestrian facilities.
7. Indicate all directional signage and directional arrows.
8. Indicate the proposed surface improvements in the areas of temporary pedestrian facilities.

1.3 QUALITY ASSURANCE

A. Structural loads shall be calculated according to the Massachusetts Building Code.

B. Electrical components shall conform to the Massachusetts Electrical Code.

C. Temporary pedestrian facilities shall conform with:

1. Americans With Disabilities Act, Accessibility Guidelines for Buildings and Facilities
2. Rules and Regulations of the Massachusetts Architectural Access Board
3. Massachusetts Building Code
4. Manual on Uniform Traffic Control Devices
5. Occupational Health and Safety, Code 1926
6. Town of Acton Traffic Department Guidelines

1.4 PROJECT CONDITIONS

A. Coordination will be required with the work requirements to install permanent paved walkways and curbs.

PART 2 - PRODUCTS

2.1 CONCRETE

A. Precast concrete barriers meeting the Massachusetts Highway Department Standard Specification 629. Precast barriers are the only acceptable barrier where pedestrians are being protected from vehicular traffic.

2.2 METALS

A. Chain-link fence meeting the Specification 02444 except that vinyl coated fabric is not required for temporary fencing.

B. Hot galvanized pipe, ASTM A53 Type E, Grade B coated with zinc inside and outside. Brackets, plates, anchoring elements, and miscellaneous components shall be hot-dip galvanized.

C. Welding shall conform to AWS D1.1 Structural Welding Code-Steel and AWS D1.3 Structural Welding Code-Sheet Metal.

2.3 WOOD

A. Wood and Timber Members: Suitable for service, sized to limit deflection under full AASHTO H-20 and construction loading of 1/2 inch.

B. Lumber shall be seasoned and have a maximum moisture of 19%.

C. Dimensioned lumber shall be straight grained, sound S4S dressed lumber, grade Select Structural. Allowable species are Douglas Fir and Spruce-Pine-Fir.

D. Plywood shall be ¾ inch, exterior Medium Density Overlay.

E. Plywood flooring shall be Sturdifloor Exposure-1, exterior adhesive type, ¾ inch thick with non-skid epoxy resin and aggregate coat on exposed surfaces.

2.4 ELECTRICAL

A. Fluorescent light fixtures shall be UL listed and suitable for wet and outdoor installations. Light housing shall be 20 gauge steel seamless with white corrosion resistant finish of baked enamel, epoxy or porcelain. Lamp shall be rapid start and energy saving type. Ballast shall be 120 V, Class P, thermally protected, high power factor.

B. Electrical components shall be grounded. Metal frames shall be bonded to the electrical system grounding conductor as well as to a locally driven rod. Final installation of grounding system shall ensure that no point in the metal framing shall have a resistance measurement to local earth ground exceeding 2 ohms.

C. Conduit shall be UL listed with corrosion resistant coating for all electrical system wiring, with all fittings meeting the Massachusetts Electrical Code for outdoor installations.

2.5 MATERIALS FOR THE TEMPORARY PLATFORM AND OTHER PEDESTRAIN FACILITIES

Components of the Temporary Station Platform and other temporary pedestrian facilities will meet the requirements of permanent construction as shown on the following table:

ELEMENT	SPECIFICATION REFERENCE
Gravel Borrow	Section 02300 Earthwork
Bituminous Concrete	Section 02513 Bituminous Concrete Pavement
Tactile Edge Strip	Section 09360 Modular Tactile Surfaces
Timber Edging	Section 06100 Rough Carpentry
Variable Message Sign	Communications System Specifications
Pavement Markings	Section 02577 Pavement Marking

2.6 SHELTERS

A. Shelters for use at the station site shall be obtained from the MBTA at their Material Storage Facility. The required shelters will be transported to the site for use as part of temporary pedestrian facilities and returned to the storage facility at the end of use.

PART 3 - EXECUTION

3.1 INSTALLATION

A. For each work area where temporary pedestrian facilities are used, perform on-site assembly expeditiously to minimize interference with the walking public and vehicular traffic. Complete and

place in service all required temporary pedestrian facilities prior to the start of the construction work in the area.

B. Prepare substrate surfaces to support barriers and fences with slopes not to exceed 5% in the direction of the traveling path, and does not exceed 2% across the traveling path.

C. Firmly secure temporary pedestrian facilities to substrates as required to resist all wind, snow, dead and live loads.

3.2 MAINTENANCE

A. The Contractor is responsible to repair all temporary pedestrian facilities until they can be removed following construction

B. The Contractor shall remove snow and ice, sweep, and make all necessary repairs

C. The Contractor shall inspect all temporary facilities daily and make all necessary repairs to maintain the structural integrity and allow safe passage by the walking public and vehicular traffic.

D. Maintain decking in an acceptable condition at all times.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

No separate measurement will be made for work under this Section, but all costs in connection therewith shall be included in the item or items of work to which they pertain cost.

END OF SECTION

SECTION 02300

EARTHWORK

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies the following items.

1. Preparing subgrades for structures and landscaping
2. Excavating, backfilling and compacting for structures, tracks, and embankments.
3. Drainage course for slabs-on-grade.
4. Subbase course for bituminous and cement concrete pavements.
5. Subsurface drainage backfill for walls and trenches.
6. Excavating, backfilling and compacting for utility trenches.
7. Excavation and removal of portions of existing stone masonry bridge substructures.
8. Reconstruction of timber crib walls

B. This Section also includes placement and compaction of Gravel Borrow for structural backfill and the placement of Ordinary Borrow for fill and embankment areas. This section also includes placement of flowable compacted fill in utility trenches and other areas as directed by the Engineer.

C. The placement of Gravel for base courses shall be in accordance with Standard Specifications Section 02509, except as modified herein. Crushed stone shall be installed only in areas directed by the Engineer.

D. This Section also includes results of geotechnical laboratory tests conducted on selected samples obtained during the geotechnical subsurface investigation. The test results are included in Appendix A of this Section. The geotechnical boring logs are included in the Contract Drawings.

E. Related Work specified elsewhere:

1. Section 02010 – GEOTECHNICAL INSTRUMENTATION
2. Section 02100 – SITE PREPARATION
3. Section 02221 – DEMOLITION
4. Section 02240 – DEWATERING
5. Section 02260 – EXCAVATION SUPPORT AND PROTECTION
6. Section 02270 – SLOPE PROTECTION
7. Section 02282 – HANDLING, TRANSPORTATION AND DISPOSAL OF EXCAVATED MATERIAL
8. Section 02360 – DRIVEN PILES
9. Section 02369 – DRILLED MINI PILES
10. Section 02920 – LAWNS
11. Section 03300 – CAST-IN-PLACE CONCRETE
12. Divisions 2, 15, and 16 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.

1.2 DEFINITIONS

A. Backfill: Soil and/or fill material and/or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside a pipe from the springline to the crown of the pipe or utility and 12-in over pipe or utility in a trench unless otherwise noted, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to approximate the gravel sub-base layer (12-in plus the thickness of the bituminous or cement concrete final surface) to fill a trench.

B. Bedding Course: Granular material placed under structures or utilities to a depth of 12-in unless otherwise noted and to the springline of the pipe or utility or to the base of the structure.

C. Borrow: Geotechnically and analytically satisfactory soil imported from off-site for use as fill or backfill.

D. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

E. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices. Also called overexcavation.
2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.

F. Fill: Soil materials used to raise existing grades. Fill (Urban Fill): In-situ material known as Fill, also known as urban fill or miscellaneous fill is defined as a mixture of soil and other materials which have been located in the area through man-made processes primarily for the purpose of grading, backfilling or filling in low areas. Material commonly associated with urban fill includes, but are not limited to; glass, brick, ash, wood fragments and other similar granular materials. Urban fill shall not include boulders, ledge, consolidated rock, asphalt, concrete, railroad timbers, rail, cobblestones or any other abandoned building materials which would preclude the disposal of the urban fill as daily cover at a landfill. Material containing less than 10%, by volume, solid waste/debris, as determined by the Engineer, shall be classified as urban fill. Material that contains 10% or more solid waste/debris by volume, as determined by the Engineer, shall be classified as solid waste.

G. Soil (Natural Soils): Soil, otherwise known as natural soil, is defined for the purposes of the Contract as unconsolidated sand, gravel, silt and clay, and the organic material which has become part of the unconsolidated soil matrix.

H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, manholes, catch basins or other man-made stationary features constructed above or below the ground surface.

J. Subbase Course: Course placed between the final backfill and the bituminous or cement concrete pavement.

K. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.3 CLASSES OF EXCAVATIONS

A. All excavations required by the Contract Documents, except Contaminated Soils, Rock Excavation, Reinforced Concrete Excavation and Bituminous Concrete Excavation will be considered to be "Unclassified Excavation." This item does not include excavation for the convenience of the Contractor as per Paragraph 3.03A.6 of this Section, and does not include excavation identified as incidental to the work of other Sections.

B. Unclassified Excavation: Removal of materials regardless of the nature of the material encountered, the moisture content thereof, and the type of equipment required for excavating; and the disposal of excavated material not required or not suitable for backfill and embankment.

C. Earth Excavation
1. Structure Excavation: Removal of material for the construction of foundations for buildings, bridges, aerial structures, grade separation structures, retaining walls, headwalls, and other indicated structures where sheeting, shoring, bracing, or dewatering is required for the safe prosecution of the work. Structural Excavation does not include excavation for subways, tunnels, or drainage and utility conduits and appurtenant structures. Structure excavation includes the disposal of excavated material not required or not suitable for backfill and embankment.
2. Roadway Excavation: Removal of material for the construction of roadways, parking lots, and slopes; and the disposed of excavated material not required or not suitable for backfill and embankments. Roadway excavation does not include removal of material classified as salvaged topsoil, rock, trench, or muck excavation.

D. Rock Excavation
1. Class A Rock Excavation: Removal of any of the materials listed in paragraph 3 below when encountered within the limits of structure excavation or roadway excavation; and the disposal of excavated material not required or not suitable for embankment and backfill.
2. Class B Rock Excavation: Removal of any of the materials listed in paragraph 3. below when encountered within the limits of trench excavation or when excavating for fences, highway guard rail, posts, and bounds; and the disposal of excavated material not required or not suitable for embankment and backfill.
3. Materials: Removal of the following materials is classified as rock excavation:
   a. Solid rock which cannot be excavated without blasting, use of rippers, or breaking with hand power tools such as jackhammers for removal.
   b. Boulders, 1/2 cubic yard or more for Class B rock excavation and one cubic yard or more for Class A rock excavation, that require blasting for removal.

c. Masonry and concrete structures and pavements which require blasting, use of rippers, or hand power tools such as jackhammers for removal.

E. Muck Excavation: Removal and disposal of saturated or unsaturated mixtures of soils and organic material not suitable for bearing material, regardless of moisture content.

F. Borrow Excavation: Obtaining and transporting to the jobsite suitable material for the backfill, embankment, and subgrade, where sufficient suitable material for such purposes is not available from required excavations.

G. Trench Excavation

1. Class A Trench Excavation: Removal and satisfactory disposal of materials for the construction of masonry culverts, utilities, and other structures having a clear square span of less than eight feet, culvert ends, masonry walls, slope protection, test pits, paved waterways, construction of drains for slope or subgrade stabilization and in the construction, widening, straightening or deepening of drainage ditches and water courses in connection with pipes or structures having a clear span of less than eight feet. Class A trench excavation does not include removal of materials classified as salvaged topsoil, rock, or muck excavation.
2. Class B Trench Excavation: Removal and satisfactory disposal of all materials in excess of the initial five feet of excavation, for the construction of utilities, drainage and water pipes. Class B trench excavation does not include removal of materials classified as rock or muck excavation.

H. Embankment: Placing and compacting suitable material to form embankments and dikes, to fill areas where unsuitable material has been removed, and to fill holes, pits, and depressions to the lines and grades indicated. Disposal of excess excavated material by spreading on approved areas of the jobsite above the indicated lines and grades, when permitted by the Engineer, is not classified as embankment.

I. Structure Backfill: Placing and compacting suitable material around structures, except drainage and utility structures, to the lines and grades indicated.

J. Pervious Backfill: Furnishing, placing, and compacting pervious material behind abutments, wingwalls, and retaining walls, and around underdrains, as indicated.

K. Impervious Backfill: Furnishing, placing, and compacting impervious material as indicated.

L. Salvaging Topsoil: Removal of suitable topsoil from areas to be excavated and other areas as indicated or directed and stockpiling the material at locations as indicated or directed.

M. Fine Grading and Compacting: Grading, shaping, and compacting of excavations, backfills, embankments, and original ground upon which pavement, surfacing, base, sub-base, ballast, subballast, or structures are to be placed.

N. Grading and Finishing: Final grading and finishing of all other areas of the work not listed in paragraph L above.

O. Presplitting Rock: Presplitting rock along the indicated cut lines to produce a uniform plane of rupture, so that the resulting rock face will not be affected by subsequent fragmentation blasting and excavation operations.

P. Existing granite blocks shall be removed from existing bridge substructures where shown on the contract plans or as directed by the engineer. The blocks are varying sizes and must be removed

without damaging those blocks to remain. Any blocks damaged through the removal process shall be replaced at no cost to the authority.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Geotextile.
2. Controlled low-strength material, including design mixture.

B. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D 2487 of each on-site and borrow soil and/or fill material proposed for fill and backfill.
2. Laboratory compaction curve according to ASTM D 1557 for each onsite and borrow soil and/or fill material proposed for fill and backfill.
3. During Construction, submit written confirmation of fill lift thickness, in-place soil moisture content, and percentage of compaction to the Engineer before placing the next lift or constructing foundations.

C. Qualifications for Approving Source: Prior to earthwork operations, submit the qualifications of the persons or Agency approving the source of supply of materials and control testing and inspection.

D. Hold Point-Earthwork Operations: Submit, prior to the excavation of earthwork activities, a plan describing the earthwork operations including the frequency and locations of tests and inspections. No work shall be performed until this plan has been approved by the Engineer.

E. Hold Point-Supply and Control Inspection Results: Submit the results of all sources of supply and control inspections and tests. Submittals reviewed beyond the second rejection (or required submittal) shall be provided at no cost to the Authority and shall be reviewed by the Engineer at the Contractor's expense. No work shall be performed until the Engineer has approved the source of supply.

F. Hold Point-Material Handling: At least two weeks prior to the start of any excavation activity submit, in writing, the following for review and shall not start excavation activity until the entire submittal is acceptable to the Engineer.

1. Description of the method of dewatering excavated material and control of effluent water quality.
2. Identification of a licensed hauler and disposal facility for possible vacuum collection, trucking and disposal of contaminated aqueous liquids.
3. Locations and methods of excavating, handling, and stockpiling (if applicable) excavated material, including drainage, as specified in this Section. Describe methods to keep materials from various sources separated during stockpiling operations (if applicable).

G. 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.

H. Backfill Materials: Submit a 20 lb. sample, grain size analysis and moisture density curve performed in accordance with ASTM D422 and compaction test results (ASTM D1557 Procedure C) for each proposed source of backfill, imported material and on-site material to be reused, for review by the Engineer at least, one (1) week prior to use of the material. The grain size analysis shall indicate that the backfill material conforms to the gradation requirements specified.

I. In addition, a certification statement and analytical results shall accompany each physical sample of earth materials to be imported onto the site, including but not limited to crushed stone, loam, bedding sand, gravel sub-base, common fill and structural backfill. At a minimum the certification shall state the point of origin and that the material is free of contaminants. The certification shall include representative sample analysis from each point of origin of backfill to be used on the site. The sample(s) shall be analyzed by a certified laboratory for total metals (EPA priority pollutant metals), volatile organic compounds (EPA Method 8260), semi-volatile organic compounds (EPA Method 8270), petroleum hydrocarbons (EPA Method 8100), and Total PCBs and pesticides (EPA Method 8081 and 8082). On-site soils defined as suitable for reuse in this Section and in Section 02080 – SOIL AND WASTE MANAGEMENT can be used as backfill without providing the certification required above.

J. All sampling of soils for chemical testing shall be performed by a person experienced in sample collection and shall be either: 1) a Licensed Site Professional registered in the Commonwealth of Massachusetts; 2) a Professional Engineer registered in the Commonwealth of Massachusetts; 3) a professional Geologist registered in the Commonwealth of Massachusetts; 4) a certified groundwater/environmental professional; or 5) an authorized representative of the one of the persons listed above. Samples of each material shall be submitted to a chemical analytical laboratory, certified by the Massachusetts Department of Environmental Protection.

K. Submit additional samples and geotechnical and analytical test data and certifications for every 1000 cubic yards (every 200 cubic yards for moisture density curves) of material imported or reused on-site or anytime consistency of material changes in the opinion of the Engineer. Submit associated chemical laboratory data on the imported materials throughout the course of the Work, if requested by the Engineer, to evaluate the consistency of the source or process, at no additional cost to the Owner.

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Authority or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify the Engineer not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without the Engineer's written permission.
3. Contact utility-locator service for area where Project is located before excavating.

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

1.6 RESPONSIBILITY OF THE CONTRACTOR

A. The Contractor shall be responsible for adhering to regulations, specifications, and recognized standard practices related to soil and rock excavation during excavation and removal activities. The

Authority shall not be responsible at any time for the Contractor's violation of pertinent state or federal regulations or endangerment of laborers or others.

B. It is the responsibility of the Contractor to investigate subsoil conditions within the Project Limits. Borings, test excavations, and other subsoil investigations, if any, made by the Engineer and shown on Contract Drawings are made for design purposes. The Authority assumes no responsibility for the correctness of the information or for the actual subsoil or other conditions which may be found to exist during the progress of construction.

C. It is the responsibility of the Contractor to protect the fiber optic cables and other existing utilities within the Contract Limits. Coordination with the various utility companies shall be required for the protection of these lines as stated within these Contract Specifications.

D. The Contractor shall be responsible for all costs associated with protection, repair, or relocation of utility lines within the Contract Limits.

1.7 QUALITY ASSURANCE

A. The Engineer will make such tests as deemed necessary to determine compliance with these Specifications.

B. Source of supply. No earthwork materials will be accepted on the jobsite without written approval from the Engineer. The Contractor shall perform sufficient tests and inspections necessary to determine the acceptability of the source of supply. A Certified Testing and Inspection Agency may be used to perform such test and inspections. The qualifications of the person or agency performing these tests and inspections shall be forwarded to the Engineer for approval. Subsequent to this approval, test results showing the acceptability of the source of supply, shall be forwarded to the Engineer for approval.

C. The Engineer reserves the right to perform inspections and tests at any time during the execution of the work.

D. Notification Point. The Contractor shall give the Engineer 2 days notice in advance of control tests and inspections.

E. The Engineer will perform all sampling and testing of embankment materials, both during and after placement and compaction, at frequent intervals. Actual field density will be determined by ASTM D1556 or ASTM D2167 or, when in the opinion of the Engineer, nuclear density and moisture contents according to ASTM D2922 and ASTM D3017 produce reliable results. From the results of these tests, corrections, adjustments, and modifications of methods, materials, and moisture content may be required. No material may be covered before it is tested. Contractor shall notify the Engineer when an embankment is ready for testing.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Soil, Fill and Borrow Materials:

1. Ordinary Borrow: With the following gradation requirement.

2.

Sieve Size	Percent Passing by Weight
4-inch (102 mm)	100
No. 200	0-20

3. Gravel Borrow: With the following gradation requirement.

Sieve Size	Percent Passing by Weight
3-inch (76.2 mm)	100
1/2 inch (12.5 mm)	50-85
No. 4	40-75
No. 50	8-28
No. 200	0-10

4. Processed Gravel for Subbase: MHD M1.03.1.
5. Sand Borrow: Sand borrow shall be used as pipe bedding for all pipe with the exception of Reinforced Concrete Pipe, placed between 6 inches below pipe invert to 6 inches above pipe crown
6. Sand Borrow for Subdrains: MHD M1.04.1.
7. Controlled Density Fill (CDF): Controlled density fill shall consist of a cementitious hard excavatable mixture of aggregate, Portland Cement, air entraining admixtures and water. The material shall be of the type specified in Massachusetts Highway Department 1995 Standard Specifications for Highway and Bridges, Type 2E. Controlled density fill shall be used as trench backfill material around structures (not including manholes and catch basins) between the top of the crushed stone layer and the top of the structure. Controlled density fill shall also be used to fill abandoned utilities and around the excavation support systems as directed by the Engineer.

B. Aggregates and Related Materials:

1. Crushed Stone: Gradation as specified for MHD M2.01.01.

C. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

D. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

E. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

J. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

L. Controlled Density Fill (CDF): Materials shall meet the following standard specifications:

Portland Cement	ASTM C 150
Fly Ash	ASTM C 618
Fine Aggregate	ASTM C 33
Air Entraining Admixtures	ASTM C 260
Water	ASTM C 94 4.1.3

Fine Aggregate shall consist of clean sand with 100% passing the ½" sieve and not more than 10% passing the 200 sieve.

Mix proportions shall be as follows:

Portland Cement	30 - 50 lbs/cy
Fly Ash	250 - 400 lbs/cy
Fine aggregate	2000 - 3000 lbs/cy
Water	600 lbs/cy
Air Content	0 - 30%

2.2 TIMBER MATERIALS FOR CRIB WALL

A. (BEING DEVELOPED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork 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 02100 - SITE PREPARATION.

C. Protect and maintain erosion and sedimentation controls, which are specified in Section 02100 - SITE PREPARATION, during earthwork operations.

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

3.2 DEWATERING

A. Comply with requirements of Section 02240 - DEWATERING.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives. Use of explosives is subject to consideration by the Authority only on a case-by-case basis.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include bituminous and cement concrete sidewalks and roadways, bricks and cobbles, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
   a. 24 inches outside of concrete forms other than at footings.
   b. 12 inches outside of concrete forms at footings.
   c. 6 inches outside of minimum required dimensions of concrete cast against grade.
   d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
   e. 12 inches beneath bottom of concrete slabs on grade.
   f. 12 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch if applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work. If material remaining at bottom of trench is disturbed, recompaction shall be required.
2. Pile Foundations: Stop excavations 6 to 12 inches above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.

3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces. If material remaining at bottom of trench is disturbed, recompaction shall be required.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line unless otherwise noted.

B. 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.

1. Clearance: 12 inches each side of pipe or conduit.

C. 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.

1. 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. If material remaining at bottom of trench is disturbed, recompaction shall be required.
2. 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.
3. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.8 SUBGRADE INSPECTION

A. Notification Point - Notify Engineer when excavations have reached required subgrade.

B. If Engineer determines that unsatisfactory soil is present, continue excavation and replace with backfill with crushed stone wrapped with non-woven geotextile fabric.

C. Proof-roll subgrade below the building slabs and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.

3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with crushed stone wrapped with non-woven geotextile fabric.

D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi may be used when approved by Engineer.

1. Fill unauthorized excavations under other construction or utility pipe with crushed stone wrapped with non-woven geotextile fabric as directed by Engineer.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 MATERIAL TRANSPORT

A. All soils transported on and off-site shall be loaded by the Contractor into properly licensed and permitted vehicles.

B. Trucks used to transport the materials shall be constructed and loaded so as to prevent any of the load from dropping, sifting, leaking, or otherwise escaping during transport. All trucks shall be equipped with tarps or other substantial type covers which shall be used to prevent any materials from spilling during transport.

3.12 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.13 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of water, mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Sand borrow bedding shall be placed by hand shovels, in layers not more than 4-inches thick in loose depth, and each layer shall be thoroughly and evenly compacted by tamping on each side of the pipe to provide uniform support around the pipe, free from voids. Crushed stone bedding material shall be placed in layers not more than 6-inches thick in loose measure, and compacted with at least 4 passes using a vibratory plate or roller compactor.

C. Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 03300 - CAST-IN-PLACE CONCRETE.

D. Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase.

E. Place and compact initial backfill of material free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Backfill voids with satisfactory soil while installing and removing shoring and bracing.

G. Place and compact final backfill of satisfactory soil to final subgrade elevation in uncompacted layers not to exceed 9 inches.

H. The Contractor shall not place backfill against or on structures until they have attained sufficient strength to support the loads (including construction loads) to which they will be subjected, without distortion, cracking or other damage. As soon as practicable after the structures are structurally adequate and other necessary work has been satisfactorily completed, the Contractor, as required by the Engineer, shall make special leakage tests of the structures. After the satisfactory completion of leakage tests and the satisfactory completion of any other required work in connection with the structures, the backfilling around the structures shall proceed using Controlled Density Fill (CDF) material. Symmetrical backfill loading shall be maintained. Special care shall be taken to prevent any wedging action or eccentric loading upon or against the structures.

I. Install warning tape directly above utilities, no less than 12 inches above the crown of the pipe or utility and no more than 16 inches above the crown of the pipe or utility.

3.14 EMBANKMENT FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.15 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.16 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 12 inches in loose depth for material compacted by heavy compaction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent minimum; and areas within 10 feet of structures, building slabs, steps, and pavements at 95 percent minimum.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent minimum.
3. Under lawns, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent minimum.
4. Under unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent minimum.
5. For utility trenches, compact each layer of initial and final backfill soil material at 95 percent minimum.
6. For embankments, compact each layer at minimum 92 percent minimum.

3.17 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Lawn or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.18 SUBSURFACE DRAINAGE

A. Subdrainage Pipe: Specified in Section 02400 - DRAINAGE AND SEWER SYSTEMS.

B. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material layer to 90 percent of maximum dry unit weight according to ASTM D 1557.

C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with 1 layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material layer to 90 percent of maximum dry unit weight according to ASTM D 1557.
2. Place and compact impervious fill over drainage backfill in 6-inch-thick compacted layers to final subgrade.

3.19 SUBBASE COURSE

A. Place subbase course on subgrades free of water, mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course under pavements and walks as follows:

1. Shape subbase course to required crown elevations and cross-slope grades.
2. Place subbase 6 inches or less in compacted thickness in a single layer.
3. Place subbase that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
4. Compact subbase course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

C. Pavement Shoulders: Place shoulders along edges of subbase and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.20 DRAINAGE COURSE

A. Place drainage course on subgrades free of water, mud, frost, snow or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 90 percent of maximum dry unit weight according to ASTM D 1557.

3.21 FIELD QUALITY CONTROL

A. Testing Agency: The Contractor shall engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.

D. An Independent Laboratory or the MBTA Laboratory will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than 3 tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least 1 test for each 100 feet or less of wall length, but no fewer than 2 tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for each 150 feet or less of trench length per lift, but no fewer than 2 tests.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained. MBTA will conduct confirmatory testing.

3.22 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.23 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off the User Agency's property.

3.24 MONITORING OF EXCAVATION

A. The Contractor shall monitor the performance of components of the excavation support system, both for vertical and horizontal movement, at intervals specified below. If the Response Values as specified in Section 02010, Table 02010-2 are reached at any time during the work, the Contractor shall immediately stop work and implement approved contingency plans.

B. Possible effects of the excavation on the lateral support system:

1. Deflection of the wall into the excavation due to soil, groundwater, and surcharge loads.
2. Settlement adjacent to the lateral support wall due to inward deflection of the wall.
3. Settlement adjacent to the lateral support wall due to ground loss into the excavation through gaps and voids in the wall.

C. Monitoring Deflection of Wall

1. Once the wall is installed to final elevation but before excavation begins, establish deformation-monitoring points on the top of the wall, spaced approximately every 20 feet along the wall (every other soldier pile). The monitoring points shall consist of painted marks on the steel member.
2. Perform a baseline survey of each deformation monitoring point before excavation begins. Survey both vertical and lateral (into proposed excavation) position.
3. Perform daily survey of each top-of-wall deformation monitoring point from when excavation begins until full excavation depth is reached adjacent to the wall. Thereafter, perform weekly survey of monitoring points until the wall is backfilled.

D. Monitoring Track Movement

1. Before the start of excavation and wall installation, install surface settlement points as defined in Section 02010 in the railroad ties along both the inbound and outbound tracks spaced approximately every 20 feet along the walls and to 100 feet beyond either end of the walls.
2. Perform two baseline elevation surveys of the surface settlement points before the start of excavation/wall installation. Survey both vertical and lateral (into excavation) positions.
3. Perform daily survey of settlement monitoring points from the beginning of excavation work until the track support structure is completed.
4. Perform weekly following completion of the track support structure until all work for the access structure completed including all concrete work, backfill and compaction. Landscaping work

shall not be considered an outstanding work item.

5. Any existing structures supporting tracks or embankments adjacent to tracks in the vicinity of work, such as bridges, abutments, retaining walls, or other structures where settlement, deflection, or failure could affect the tracks shall be included in any monitoring program.

E. Make adjustments to survey schedule and monitoring point locations (including the addition of monitoring points) as requested by the Engineer if additional monitoring of wall performance is desired. Extra monitoring points and increases in survey frequency shall be considered incidental to the costs associated with this Section.

F. All monitoring data shall be reported to the Engineer within forty-eight (48) hours of measurement in tabular and graphical format, allowing comparison of current data to previous data, including baseline data.

3.25 TIMBER CRIB WALL

A. (BEING DEVELOPED)

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. The following classifications of work will be measured by the cubic yard unless otherwise indicated:

1. Unclassified Excavation
2. Structure Excavation
3. Rock Excavation, Class A and Class B
4. Borrow Excavation, including Ordinary Borrow, Gravel Borrow, Gravel Borrow for Bridge Foundation, Crushed Stone, Sand Borrow and Special Borrow.
5. Embankment
6. Structure Backfill
7. Pervious Backfill
8. Impervious Backfill
9. Salvaging Topsoil
10. Trench Excavation.
11. Granite Block Excavation

B. Quantities for Fine Grading and Compacting, and Presplitting Rock will not be measured separately for payment, but all costs in connection therewith will be considered incidental to the items of work to which they pertain.

C. Grading and Finishing will not be measured separately for payment, but all costs in connection therewith will be considered incidental to the items of work to which it pertains.

D. Compacting original ground will not be measured separately for payment, but all costs in connection therewith will be considered incidental to the embankment to be constructed on the compacted original ground.

E. Quantities of excavation and backfill will be determined from limits indicated or specified herein, or in the Construction Specifications, plus any additional excavation and backfill authorized or required by the Engineer not due to the Contractor's negligence. Where limits for excavation and backfill are not indicated, the quantities will be computed within the following limits:

1. The horizontal limits for computing pay quantities shall be vertical planes one foot outside the neat lines of footings or structures.
2. The upper limit for payment for excavation shall be the ground surface as it existed prior to the start of construction operations. Where it is required that the excavation be made in new embankment, the upper limit shall be the planes of the new embankment at the elevation indicated or directed for construction in advance of performing the required excavation, but in no case shall the upper limit be above the planes of the new embankment.
3. The upper limit for payment of backfill, when not indicated, shall be the ground line at the time the excavation is made; except, when backfill is ordered to a higher limit by the Engineer, limit for payment shall be the higher limit ordered.
4. The lower limits for computing pay quantities of excavation and backfill shall be a plane at the bottom of the completed footings, structures or trench, unless excavation of unsuitable material is ordered to lower depth.
5. Trench Excavation for utility lines and structures will not be measured separately for payment, but all costs in connection therewith will be considered incidental to the items of work to which they pertain.

F. Quantities of pervious and impervious backfill and borrow will be determined from the dimensions indicated or the dimensions authorized or required by the Engineer.

G. Excavation for the Contractor's convenience, unauthorized excavation outside the limits indicated and backfill of such excavations will not be measured for payment.

H. Re-excavation and rehandling of stockpiled material will not be separately measured for payment, but will be considered incidental to the earthwork to which it pertains.

I. Test Pits will be measured by the cubic yards of material excavated, as directed by the Engineer.

J. Unless otherwise indicated, grading, shaping, and compacting of that portion of excavations, backfills, embankments, and original ground, upon which pavement, ballast, subballast, Hot Mix Asphalt underlayment, or structures are to be placed, will not be measured separately for payment, but all costs in connection therewith will be considered incidental to the items of work to which they pertain.

K. Rock Measurement: Volume of rock actually removed to the limits indicated in the Contract Documents measured in its original position. Payment includes, but is not limited to replacement with approved materials and disposal of excess rock.

L. Granite Block Excavation includes the volume of stone masonry actually removed from existing bridge substructures to the limits indicated on the Contract Documents measured in its original position.

M. Control Density Fill (CDF) will not be measured separately for payment, but all costs therefore will be included in the contract unit and lump sum prices for the items of work to which they pertain.

N. Timber Crib Wall reconstruction will be measured by the square foot of exposed wall face complete in place.

4.2 PAYMENT

A. The unit price bid per cubic yard for excavation associated with Test Pits and for excavation of rock materials, reinforced concrete, bituminous concrete, or other materials shall include all costs of excavating such material, including handling, on-site reuse, and off-site disposal, and furnishing all labor, materials, equipment, and incidentals necessary to satisfactorily complete the work. The unit price bid per cubic yard for Unclassified Excavation shall include the cost of excavating such material and any on-site reuse of such material as ordinary and gravel borrow, including placing and compaction, and furnishing all labor, materials, equipment and incidentals necessary to satisfactorily complete the work. The cost of all other handling, testing, and environmental categorization of all Unclassified Excavation soil materials and off-site transport and disposal of surplus, unsuitable, or contaminated excavated soil materials is separately measured and paid for in accordance with the provisions of Section 02282.

B. Where the depth of Class A trench excavation is greater than eight feet, as indicated, excavation below eight feet will be paid for at a price equal to 1-1/2 times the cubic yard price bid for Class A trench excavation, except that no such adjustment will be allowed for excavation of open ditches exceeding eight feet in depth or for excavation required for slope protection regardless of depth.

C. The unit price bid per cubic yard for Ordinary Borrow, Gravel Borrow, Gravel Borrow for Bridge Foundation, and Crushed Stone and the unit price bid per ton for Compacted Gravel Subbase shall include the cost of furnishing, placing and compacting the subgrade and borrow material, including all labor, materials, equipment and incidentals necessary to satisfactorily complete the work.

D. Payment for Timber Crib Wall will be made at the Contract Unit Price bid for Item 0614.000 – Timber Crib Wall, which price shall include all costs associated with layout of proposed walls, removal of portions of existing timber crib walls, preparation of foundation base materials, realigning and installation of existing wall timbers, furnishing and installing required new wall timbers, hardware, equipment, materials, labor, submittals, permits and incidentals required to satisfactorily complete the work.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0222.003	UNCLASSIFIED EXCAVATION	CY
0222.103	ROCK EXCAVATION – CLASS A	CY
0222.104	ROCK EXCAVATION – CLASS B	CY
0222.105	REINFORCED CONCRETE EXCAVATION	CY
0222.124	BITUMINOUS CONCRETE EXCAVATION	CY
0222.130	GRANITE BLOCK EXCAVATION	CY
0222.402	BRIDGE EXCAVATION	CY
0222.442	TEST PITS	CY
0222.501	ORDINARY BORROW	CY

0222.504	GRAVEL BORROW	CY
0222.550	LOAM BORROW	CY
0222.507	GRAVEL BORROW FOR BRIDGE FOUNDATION	CY
0222.571	COMPACTED GRAVEL SUBBASE	TN
0222.628	CRUSHED STONE	CY
0614.000	TIMBER CRIB WALL	LS
0222.615	BALLAST	TN
0222.631	SUB-BALLAST	TN
0222.550	LOAM BORROW	CY

APPENDIX A: GEOTECHNICAL LABORATORY TEST RESULTS

SECTION 02369

DRILLED MINI PILES

PART 1 – GENERAL

1.1 GENERAL

A. This Section specifies furnishing and installing Drilled Mini Piles where shown on the contract Drawing and as specified herein.

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. Where the drilled mini piles are within 10 feet of retaining wall footings or other excavation, at a minimum, the top of the bearing zone for the piles shall be 1 foot below the proposed bottom of excavation or 5 feet below existing ground surface, whichever is deeper.

C. Where drilled mini piles are located within ten (10) feet of excavations, all excavation, associated construction and subsequent backfill and compaction shall be completed to the satisfaction of the engineer prior to commencement of drilled mini pile installation.

D. Coordinate work with that of all other trades or contracts affecting or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

E. Contractor shall note that installation of mini piles is along an active railroad right-of-way. The contractor shall plan his work accordingly. All construction activities shall follow pertinent safety procedures as outlined by the Authority and as noted in various Sections included in the specifications.

1.2 DESCRIPTION OF WORK

A. The Contractor shall be responsible for furnishing all work and materials for the design and installation of drilled mini piles. Drilled mini pile work includes but is not limited to the following items:

1. Drilled mini pile foundation system including, but not limited to, appropriate drilling technique, pile diameter, pile length and reinforcement.
2. Provide all equipment necessary for the installation of drilled mini piles at the locations indicated on the Drawings.
3. Providing all equipment and materials for the protection of existing structures, track, pedestrians, and all ancillary facilities located within the work area.
4. Installation of drilled mini piles through whatever material encountered to the depth required by design. The equipment shall be capable of drilling through boulders, and any other obstructions, encountered during installation at no additional cost.
5. Hauling and legal disposal, in accordance with Section 02200 - Earthwork, of all excavated materials and excess grout from the drilled concrete mini pile shaft which cannot be reused on site.
6. Provide debris shields and other equipment or materials required to contain all excavated material within the immediate work area.
7. Install temporary steel casing during drilling to limit ground loss at adjacent existing foundations, and adjacent to active railroad tracks.

8. Furnish and installation of steel reinforcing, concrete, grout, permanent casing and centering devices as required.
9. Removal of grout/concrete over pour or other irregularities, which interfere with other structural elements or utilities.
10. Drilled mini piles shall be cut-off at the elevations shown on the Contract Drawings at no additional cost.
11. Perform one load test as specified herein.

B. Related Work Specified Elsewhere:

1. Section 02240 – Dewatering
2. Section 02260 – Excavation Support and Protection
3. Section 02300 – Earthwork
4. Section 03300 – Cast in Place Concrete

1.3 SUBMITTALS

A. Provide submittals to the Engineer for review at least 14 days prior to commencing pile installation. Review of the submittals by the Engineer will not relieve the Contractor of the responsibility to provide and install mini piles capable of supporting the design loads specified herein. Submit items of this Article in a single submittal package. Submittals shall include the following:

1. Design calculations and shop drawings for piles prepared by a Professional Engineer registered in the Commonwealth of Massachusetts, as evidenced by the imprint of his/her seal and signature on the document.
2. Use the following minimum design guidelines:
   a. The Massachusetts State Building Code.
   b. Minimum drill hole diameter of 10-inches (min O.D. casing 9 5/8" Dia.).
   c. Minimum design compression capacity of 50 tons per pile, minimum design tensile capacity of 15 tons per pile, and minimum lateral design capacity of 2 tons per pile
   d. Review available boring logs for soil strata (Appendix A of these Specifications).
   e. Permanent pile casing shall remain at top 5 feet (min.) of pile.
   f. A minimum of 40 percent of design load must be carried by steel reinforcing, and permanent steel casing if used.
   g. Minimum factor of safety for soil to pile bond shall be 2.0.
   h. Maximum allowable steel stress of 40 percent of minimum specified yield strength, up to 24 ksi maximum.
   i. If permanent steel casing is used as pile reinforcing, increase the outer dimension of steel by 1/8 inch to allow for corrosion.
   j. Temporary and permanent casing may be the same.
   k. Maximum allowable concrete stress of 33 percent of specified 28-day unconfined compressive strength, up to 1,600 psi maximum.
   l. Neglect friction capacity in soil over the top 5 feet of the pile below ground surface.
   m. Minimum penetration length in glacial till soils shall be 15 feet (resulting in 20 foot long piles below ground surface).

   n. If less than 20 feet of soil is encountered, piles shall derive support from friction in sound bedrock only. Bedrock to be classified by engineer.

o. Minimum penetration length in bedrock shall be 5 feet (pile lengths will vary depending on where top of rock is encountered below ground surface). Top of bedrock shall be determined by engineer. Weathered rock will not be classified as bedrock.

p. Capacity of piles in soil and piles in bedrock shall be confirmed with pile load tests performed by the Contractor.

3. Cement grout or concrete mix design proposed for mini pile and strength test data for that mix by an independent testing laboratory certified by the Commonwealth of Massachusetts. Provide test results, and manufacturer's literature of any admixtures such as mineral fillers, fluidifiers, retarders, etc.
4. Manufacturer's literature and certification for pile steel reinforcement. All reinforcement shall be galvanized or epoxy coated.
5. Description of equipment and procedures for installation of piles including method of advancing the hole through soils and boulders, method to assure the drilled hole has the minimum required diameter before concreting/grouting the drilled hole, the method to flush the drilled hole, and method of measuring volumes of concrete/grout to be placed for each pile and pressure concreting/grouting system details, as applicable. Also include details of centering devices for steel reinforcing.
6. Method of pressure concreting/grouting the annular space between the permanent casing and the drill hole as the temporary casing is withdrawn.
7. Method of transferring loads from the proposed concrete pier caps to the mini piles shall be detailed in shop drawing submittals. The pile reinforcing shall be spliced /coupled with the reinforcing detailed on contract drawings.
8. Means of monitoring verticality of the drill hole in the two principal perpendicular planes during drilling and details of proposed corrective measures to be implemented as necessary.
9. Submit details of proposed equipment, methods, and sequence of operation to remove and dispose of, or advance through, obstructions, which are anticipated.
10. Submit record information as specified in Article 1.08 of this Section for all mini pile installations, including test piles.
11. Load test location, procedures and equipment (refer to Articles 2.02 and 3.03 herein). Provide shop drawings with details of the load test setup including test mini pile, reaction system layout, load cell and hydraulic jack, tell tales or strain gages, and anticipated subsurface conditions at the test pile location. Provide reaction system design calculations prepared by a Professional Engineer registered in the Commonwealth of Massachusetts. Provide calibration records for the load cell and hydraulic jack to be used, prior to conducting the load test. Submit load test report as specified in Article 3.03 of this Section. Drilling for production mini piles shall not begin until load test data have been reviewed by the Engineer.

B. Submit record information specified in Article 1.08 of this Section (except grout test results) within 24 hours of completing each pile. The results of testing of grout samples shall be submitted within 24 hours of obtaining the data.

1.4 PROJECT CONDITIONS

A. The Contractor shall protect existing structures from damage. This includes existing railroad tracks, buildings, roadways, sidewalks, equipment, and utilities. All construction induced damage shall be repaired by the Contractor to the satisfaction of the Engineer at Contractor's expense.

B. The Contractor shall visit the site to review all details of the work and working conditions, including site access issues, to verify dimensions in the field and to advise the Engineer of any discrepancy before performing any work.

C. The Contractor shall consult Contract Drawings and official records of existing utilities, both surface and subsurface, and their connections to be fully informed on all existing conditions and limitations as they apply to this Work and its relation to other construction Work.

D. The Contractor shall protect existing utilities to remain in service within the pile installation Work zone in accordance with the requirements of authorities having jurisdiction over same. The Contractor shall repair or replace any construction induced damage to the satisfaction of the governing utility at the Contractor's expense.

E. Temporary casing will be required during drilling to prevent the loss of ground below adjacent structures and railroad tracks. Permanent casing is required for the top 5 feet of pile (minimum) below pile cut off elevation, and where required to prevent squeezing of the drill hole and assure the full cross section of the pile.

F. The Contractor shall be responsible for implementing all necessary traffic control measures, which may include but not be limited to traffic cones, barriers, barrels, signs, flagmen and police details.

1.5 SUBSURFACE SOIL DATA

A. Review logs of borings, record of investigations, and other pertinent data for the site (Appendix A of these specifications). After obtaining MBTA's permission, take whatever additional borings or explorations deemed necessary at no expense to MBTA.

B. Subsurface explorations and the urban site location/fill area indicate possible below grade obstructions within the limits of the Project. Such obstructions include, but are not necessarily limited to, boulders in the soils above and within the gravelly sand and glacial till, and various construction debris. Refer to the attached boring logs for additional information. The Contractor is responsible for drilling through obstructions where they are encountered.

C. Aforementioned data is for general information and is accurate only at the particular locations and time the subsurface explorations were made. It is the Contractor's responsibility to make interpretations and draw conclusions on the character of materials encountered and the impact on this work based on his expert knowledge of the area and of pile installation techniques.

D. Perform one load test each for piles installed into bedrock, and for piles installed entirely in soil.

1.6 QUALITY ASSURANCE

A. Provide written statement verifying the Contractor has successfully completed at least three projects of similar size and complexity in this type of installation. Identify the design consultant and owner for each project. Provide written documentation of the competence and experience of the person who will be in charge at the site.

B. Employ within the Contract Price, a Registered Land Surveyor or Registered Professional Engineer familiar with this type of work to:

1. Establish lines and grades.
2. Establish actual pile locations.

1.7 TOLERANCES

A. Maximum variation of any pile from its planned or indicated location at the cut-off elevation shall not exceed one inch (1") unless approved by the Engineer.

B. Maximum verticality variation of any pile from design is 1 horizontal to 50 vertical (1:50) ratio.

C. Cut-off elevation shall be within ½ inch of elevation shown on the plans.

1.8 PROJECT RECORD DOCUMENTS

A. Submit as-installed records and drawings including the following information to the Engineer within one day after completing each mini pile installation, including test piles. Data shall include:

1. Date and time of drilling and grouting.
2. Pile numbers, sizes, lengths, and locations of pile.
3. Sequences of installations.
4. Condition of the bottom of the drill hole.
5. Verticality information.
6. Tip elevation of each pile to nearest 0.1 ft.
7. Cut-off elevation of each pile to nearest 0.1 ft.
8. Show locations of centers of as-installed piles on a drawing in relation to design location to the nearest 0.01 ft. Indicate magnitude and direction from plan location.
9. Volume of grout used and injection pressure.
10. Reinforcing steel details, including elevation of splices to nearest 0.1 ft.
11. Grout samples taken for testing.
12. Elevation of centralizers to nearest 0.1 ft.
13. Soil profile encountered during drilling to nearest 0.5 ft.
14. Length and elevations of temporary steel casing used.
15. Length and elevations of permanent steel casing used.

B. Submit final as-installed records and drawings of each pile installed to the Engineer within three (3) days after completion of the Work of this Section.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cement Grout

1. Cement grout shall be a mixture of Portland Cement (Type II) and clean, potable water proportioned and mixed to maintain solids in suspension without appreciable water gain and flowable to provide good bonding in the bearing stratum.
2. 28-day minimum compressive strength of 4,000 psi.
3. Admixtures shall be used in accordance with manufacturer's recommendations.

B. Reinforcing Bars

Minimum Grade 60 Deformed Bar, free of rust, grease, oil, dirt, or other objectionable material at the time of placement into the pile.

C. Reinforcing Steel Splice Couplings

Couplings shall develop at least 125 percent of the specified yield strength of the rebar in compression and tension. No lap splices shall be used.

D. Permanent Steel Casing

Minimum Grade A36 steel casing shall be free of grease, oil, dirt or other objectionable material at the time of placement into the pile to the depths specified herein. Casing shall be continuously joined with sufficient strength and rigidity to maintain the required mini pile dimensions. Casing used during drilling may be left in place permanently.

E. Centralizers

As required to maintain alignment of reinforcing steel in the center of the drilled pile and to provide minimum required grout cover.

2.2 LOAD TEST

A. Calibrate load cells and hydraulic jack, including complete assembly of pumps, gages, and ram to be used in the load test for this project by an approved laboratory. Perform a minimum of three calibration runs at ram extensions of one inch, mid range and one inch less than full range within 2 weeks of load test.

B. Conform to ASTM D1143 for equipment type, reaction system, load instrumentation, and deflection monitoring.

C. Provide reaction frame capable of safely supporting 125 percent of the maximum test load.

D. See Article 3.04 of this Section for remedial actions for non-conforming piles.

PART 3 - EXECUTION

3.1 PREPARATION FOR DRILLING

A. The Contractor shall verify that site conditions will allow for access of proposed equipment and will support equipment for pile installation.

B. The presence of utilities, existing structures and other obstructions, including but not limited to, boulders in the soil layers above and in the gravelly sand and glacial till and construction debris will require strict adherence to the planned drilling locations shown on the Drawings. Any interferences encountered in the drilling of piles shall be brought to the attention of the Engineer.

C. Utilize the same equipment for all production and test piles.

D. Mark or stake all pile locations and provide ground surface elevations.

3.2 INSTALLATION

A. Drilled concrete pile installation shall generally consist of the following method:

1. Drill holes to required depth using rotary or percussion methods.

    a. Provide temporary steel casing during drilling. Casing shall be continuously joined and shall have the strength and rigidity to maintain the required excavation dimensions. Driving of casing will not be allowed. Drilling shall be performed such that the cuttings and wash fluid return through the inside of the casing. External flush will not be allowed. The method of drilling used shall prevent the loss of ground due to erosion, jetting, or blow-in at the bottom of the casing. No open hole drilling will be allowed unless approved by the Engineer.
    b. Maintain and verify that hole is open and clear for installation of steel reinforcement and cement grout.
    c. Minimum hole diameter of 10 inches as determined by outside diameter of casing unless the Contractor can verify that a larger diameter is developed by installation techniques.
    d. Legally dispose of all materials removed from holes not reused on site in accordance with Section 02200-Earthwork.
2. Flush holes with water or slurry prior to installing reinforcing steel or cement grout until all contaminated water and cuttings are removed and a clean return is observed. Use an internal circulation method which will not alter soil stability or aggravate existing environmental conditions.
3. Verify drill hole has not collapsed and has the specified minimum diameter along its entire length.
4. Place cement grout by tremie method in accordance with PTI "Recommended Practice for Grouting of Post-Tensioned and Prestressed Concrete" as applicable. Place tremie pipe to bottom of pile. Maintain tremie pipe at least five feet (5') below grout surface until casing is filled with good quality grout to cut-off elevation.
5. Install reinforcing steel with centralizers to full depth of pile at time of grouting. Provide reinforcing steel splices, if required. Centralizers shall be placed along the entire length of pile no greater than 10 feet apart.
6. Install permanent casing to required depth (5 foot minimum below pile cut off) prior to removing temporary drill casing unless casing used during drilling is left in place to serve as permanent casing.
7. If drilling casing is not used as permanent casing:
    a. As the grout column drops in the hole during withdrawal of the temporary casing, pump grout under pressure through the casing to fill any space between the temporary casing and the drill hole with grout. Also, verify that the annular space between the permanent casing and drill hole is filled with grout.
    b. Maintain pressure on the grout and a positive flow of grout into the pile hole after withdrawing each length of temporary casing.
    c. Check grout level before, during and after withdrawing casing to confirm that separation of grout has not occurred.
8. Grouting of a pile shall be completed on the same day that the pile is drilled. Obtain grout samples from the end of the tremie grout line for each pile. Grout specimens will be prepared and tested by the Engineer or his/her representative, in accordance with ASTM C109, at no cost to the Contractor.

9. Place at least 100 percent of the theoretical volume of grout based on the outside diameter of the casing, if temporary casing is not left in place to serve as permanent casing. Notify the Engineer immediately if the actual grout take is less than the theoretical volume of grout.

B. Do not allow vibration or excessive wheel loads to influence piles during installation and construction. Keep excavation stable at all times.

1. Where obstructions make it impossible to install certain piles at locations shown on the Contract Drawings and/or to the proper depths, resort to all usual methods for pile installation. If in the judgment of the Engineer the Contractor is unable to complete the proper installation of any pile, after resorting to such methods, the Engineer may require that an additional pile or piles be installed or that other remedial action be taken, for which the Contractor will be paid in accordance with the unit prices established in this contract.

2. Fill with grout any pile abandoned because of obstructions encountered before reaching the anticipated depth at no additional cost to the MBTA.

C. The Contractor shall implement all necessary traffic control and safety measures, which may include but not be limited to traffic cones, barriers, barrels, signs, flagmen and police details during pile installation activities.

3.3 PILE LOAD TEST

A. Perform a compression or tension load test in accordance with applicable ASTM standards, as specified herein, and as required by the Engineer for one pile installed into bedrock and for one pile installed entirely in soil. The maximum test load shall be twice the maximum design load of 50 tons.

B. Use the same size and type of test pile as specified for other mini piles used for this project and installed in the same manner. Install test pile such that the mini pile will not develop friction resistance above the natural gravelly sand/glacial till bearing stratum.

C. Do not begin load test until grout reaches the required design compressive strength. Allow a minimum of 3 days for the grout to cure. The Engineer or their representative will sample and test grout during test pile installation as specified herein.

D. Provide sufficient protection from the elements (rain, wind, etc.) and heating during the load test, as required, which could affect the test results.

E. Apply test loads and record load-deformation data in accordance with applicable ASTM standard loading procedure, except as specified herein. Apply loads in 25 percent increments of the proposed design load up to twice the design load. Maintain each load increment until the rate of movement of top and bottom of pile is not greater than 0.01 inch per hour, but not longer than 2 hours. Take and record time, load and deflection readings at intervals of 1, 2, 4, 8, 15 and 30 minutes following the application of each load increment. Maintain the maximum test load until the rate of movement of top and bottom of pile is not greater than 0.01 inch per hour. Remove the test load in decrements of 25 percent of the total test load with a constant time of 15 minutes between decrements. Take and record time, load, and deflection readings before the next load decrement (every 15 minutes). After reducing the load to zero, take and record rebound readings at time intervals of 1, 2, 4, 8, 15, 30, 45, and 60 minutes. In no case shall a load be changed if the rate of settlement is not decreasing with time.

F. The allowable design load will be taken as 50 percent of the maximum applied test load, or the test load resulting in a movement of 0.5 inch at the pile tip (measured using tell tales installed to bottom of pile), whichever is less. If the allowable compression load as determined by the load test is less than the required design load, the Contractor shall install an additional test pile and perform another load test at no additional cost to the MBTA.

G. Test piles may be part of the final foundation. Grout and/or cut off test piles following load test as directed by the Engineer at no additional cost to the MBTA.

H. If test piles do not conform to the specified requirements, provide additional test piles and testing, as directed by the Engineer, at no additional cost to the MBTA.

I. Submit load test report to Engineer for review within 2 days following completion of each test. Drilling for production mini piles shall not begin until load test report has been reviewed by the Engineer. Load test reports shall include the following:

1. All test pile record information specified in Article 1.08 of this Section, including a scale drawing of test piles showing all relevant construction details and subsurface conditions encountered during installation.
2. Tabular and graphical summary of the specified load-deformation data.
3. Brief memorandum summarizing testing procedure, test results, and recommended allowable design load.

3.4 NON-CONFORMING PILES

A. Non-conformance piles include piles that are installed out of tolerances, as specified in Article 1.07 of this Section, are damaged, the volume of grout placed is less than the theoretical volume of the hole, the grout tests do not indicate the specified strength has been achieved or the pile is not installed to specified bearing stratum. To mitigate and/or remedy non-conforming piles, the Contractor may be required to provide additional piles or supplement piles to meet specified requirements at no additional cost to the MBTA.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Drilled Mini Piles will be measured per each under the Contract Item No. 0230.120 Drilled Piles, complete in place.

B. Piles Load Tests for the drilled mini piles will be measured per each under the Contract Item No. 0232.228 Pile Load Tests, complete in place.

4.2 PAYMENT

A. Payment for drilled mini piles will be paid at the contract unit price as specified above. Payment shall constitute full compensation for all costs to mobilize/demobilize the Contractor's equipment, providing the required submittals, and all materials, equipment, tools and labor necessary to furnish and to install

the drilled mini piles to the specified capacity and elevations to the complete satisfaction of the Engineer.

B. Drilled mini pile load test will be paid at the contract unit price as specified above. Payment shall constitute full compensation for all equipment, labor, and materials required for the load test subject to review by the Engineer. Equipment and materials shall include, but not be limited to, load cells, hydraulic jack, complete assembly of pumps, gages, and ram, reaction system, load instrumentation, and deflection monitoring equipment.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0230.120	DRILLED PILES	EA
0232.228	PILE LOAD TESTS	EA

END OF SECTION

SECTION 02400

DRAINAGE AND SEWER SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies construction of drainage facilities and sanitary sewer facilities.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 02300 - EARTHWORK
2. Section 03300 - CAST-IN-PLACE CONCRETE

1.2 SUBMITTALS

A. Shop Drawings. Include details of sewers and drains, including relationship to other systems; true position and details of interfaces, connections, inlets, cleanouts, manholes, alignment, grade, changes of direction, offsets, bedding, protection, materials and other pertinent data.

1.3 PRESSURE AND LEAKAGE TESTING AND TOLERANCES

A. Gravity Lines: Maximum allowable leakage for any section or sections, or for the total lengths of pipelines: 200 gallons per inch of diameter per mile per 24 hours.

B. Polyvinyl Chloride PVC:

1. Testing of Pipe: After completing installation and backfill of pipe, the Contractor shall, at his expense, conduct a line acceptance test using low pressure air. Equipment used shall meet the following minimum requirements: Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be inspected; Pneumatic plugs shall resist internal test pressures without requiring external bracing or blocking; All air used shall pass through a single control panel. Three individual hoses shall be used for the following connections: From control panel to pneumatic plugs for inflation; From control panel to sealed line for introducing the low pressure air; From sealed line to control panel for continually monitoring the air pressure rise in the sealed line.
2. All pneumatic plugs shall be seal tested before being used in the actual test installation. One length of pipe shall be laid on the ground and sealed at both ends with the pneumatic plugs to be checked. Air shall be introduced into the plugs to 25 psig (172.3689 Kpa). The sealed pipe shall be pressurized to 5 psig (34.47378 Kpa). The plugs shall hold against this pressure without bracing and without movement of the plugs out of the pipe.
3. After a manhole to manhole reach of pipe has been backfilled and cleaned, and the pneumatic plugs are checked by the above procedure, the plugs shall be placed in the line at each manhole and inflated to 25 psig (172.4 Kpa). Low pressure air shall be introduced into this sealed line until the internal air pressure reaches 4 psig (27.579 Kpa) greater than the average back pressure

of any groundwater that may be over the pipe. At least two minutes shall be allowed for the air pressure to stabilize.

4. After the stabilization period (3.5 psig (24.1317 Kpa) minimum pressure in the pipe), the air hose from the control panel to the air supply shall be disconnected. The portion of line being tested shall be termed "Acceptable" if the time required in minutes for the pressure to decrease from 3.5 to 2.5 psig (24.1317 to 17.2369 Kpa) (greater than the average back pressure of any groundwater that may be over the pipe) is not less than the time shown for the given diameter in the following table.

Pipe Diameter	Specification Time for Length Shown (min: sec)			
Inches	100 ft.	200 ft.	300 ft.	400 ft.
6	5:40	5:40	5:40	5:42
8	7:34	7:34	7:36	10:08
10	9:26	9:26	11:52	15:49
12	11:20	11:24	17:05	22:47
15	14:10	17:48	26:42	35:36
18	17:00	25:38	38:27	51:16
21	19:50	34:54	52:21	69:48
24	22:47	45:34	68:22	91:10

5. In areas where groundwater is known to exist, the Contractor shall install a 1/2 inch (1.27cm) diameter capped pipe nipple, approximately 10 inches long, through the manhole wall adjacent to one of the sewer lines entering the manhole. This shall be done at the time the line is installed. Immediately prior to the performance of the Line Acceptance Test, the groundwater shall be determined by removing the pipe cap, blowing air through the pipe nipple into the ground so as to clear it, and then connecting a clear plastic tube to the nipple. The hose shall be held vertically and a measurement of the height in feet of water over the invert of the pipe shall be taken after the water has stopped rising in this plastic tube. The height in feet shall be divided by 2.3 to establish the pounds of pressure that will be added to all readings. (For example, if the height of water is 11 1/2 feet, then the added pressure will be 5 psig. This increases the 3.5 psig to 8.5 psig, and the 2.5 psig to 7.5 psig. The allowable drop of one pound and the timing remain the same). In no case shall the starting pressure exceed 9.0 psig.
6. If the Contractor is unable to pass a pressure test because lines are "live", the Contractor shall perform closed circuit television inspections of the lines at no additional cost to the Authority. The Engineer must be able to witness the tests and must be provided with a video recording of each test for further inspection.
7. Test Failure: If the section of pipe fails to pass the leakage and pressure test, or if there is any visible leakage, the Contractor shall locate, uncover and repair or replace the defective pipe fitting or joint and retest all at his own expense. Pipe will be considered passing only when the leakage does not exceed the above standard. Passing the test does not absolve the Contractor from his responsibility if leaks develop later within the period of warranty.

C. RCP:

1. Leakage Tests: Leakage tests will be required by the Authority for all pipe and manhole installations. Tests shall meet all requirements of this paragraph. Leakage into or from the piping and structures, except storage tanks, will be determined respectively by infiltration tests or by exfiltration tests, as specified herein and as directed. The maximum allowable amount of infiltration into the piping or exfiltration from the piping as determined respectively by the infiltration tests or by the exfiltration tests, including manholes, shall be at a rate of not greater than 150 gallons (567.8l) per inch of pipe diameter per mile of pipe per 24 hours, and there shall be no gushing or spurting streams of water into or from the piping or manholes. The phrase, "per mile of pipe" shall refer to the total length of pipe measured through manholes. Where the groundwater level can be maintained at a height of not less than one foot (304.8 mm) above the top of the pipe for the full length of the section of pipe being tested for leakage, the leakage into the piping and manholes shall be determined as specified under "Infiltration Tests." Where the groundwater cannot be maintained at a level of not less than one foot (304.8 mm) above the top of the pipe for the full length of the section of pipe being tested, the leakage from the piping and manholes shall be determined as specified under "Exfiltration Tests". Perform all work, provide all necessary weirs or such other measuring devices as required, do all pumping and furnish all equipment necessary for the proper performance of leakage tests at no additional cost to the Authority. Leakage testing of piping shall be satisfactorily performed in sections as the work progresses, and as directed.
2. Infiltration Tests: The tests shall be conducted at such times as the groundwater level is at a height of not less than one foot (304.8 mm) above the top of the pipe for the full length of the section of the pipe being tested. The groundwater leakage into the pipe will be measured by the Authority at such point or points as he may direct. Construct such weirs or other means of measurement as required and pump as necessary for the tests to be properly made.
3. Exfiltration Tests: Where exfiltration tests are required, the section of pipe to be tested shall be subjected to an internal pressure. The lower end of the section of pipe to be tested shall be closed and the entire section of the pipe, including manholes, shall be filled with clean water so as to obtain a minimum head of 2 feet (0.6096 m) above the top of the pipes; the length of the section of pipeline being tested shall be such that with the head of water 2 feet (0.6096 m) above the top of pipe at the upper end of the section of the pipeline being tested will not exceed 8 feet (2.4384 m). The rate of leakage from each section of the pipe being tested will be determined by the Authority by measuring the amount of water required to maintain the minimum head of 2 feet (0.6096 m) above the top of the pipe for the full length of each section of the pipes being tested.
4. Should the infiltration or exfiltration test on any section of the pipelines, including manholes, show a rate of leakage into or from the pipeline exceeding the maximum allowable rate of infiltration or exfiltration specified herein, locate, repair, or replace defective joints and work in a manner satisfactory to the Authority and retest at no additional cost to the Authority until the rate of infiltration into or exfiltration from each section of the pipeline being tested does not exceed the rate specified herein for infiltration or exfiltration.
5. The completed pipe and joints shall be visually inspected by the Engineer. If the Contractor is unable to pass a pressure test because lines are "live", the Contractor shall perform closed circuit television inspections of the lines at no additional cost to the Authority. The Engineer must be able to witness the tests and must be provided with a video recording of each test for further inspection.
6. Tests for ductile iron gravity lines shall be conducted as indicated above for RCP.

D. Ductile Iron Force Mains:

1. Pressure Testing: All pipe and appurtenances installed shall be hydrostatically tested in accordance with ANSI/AWWA C600, latest version unless stated otherwise herein. Test pressure, expressed in terms of feet of water, applied at any point in pipe equals arithmetic

difference between specified test pressure plane elevation and elevation of horizontal center line of pipe at selected location. Multiply value by 0.433 to obtain pounds per square inch. Ensure pressure gauges are accurately calibrated. Do not attempt pressure testing until all air has been vented from the mains. All new force mains that shall become the property of the Authority shall be pressure tested at a minimum of 150 psi for a continuous period of two hours.

2. Leakage Testing: Conduct leakage testing in conjunction with pressure tests. Ensure that joints in piping are watertight and free from visible leaks during leakage test.
3. Leakage Test Pressure: Maintain specified normal operating line pressure for pressure testing of reach during leakage test. Maintain hydrostatic pressure within plus or minus 5 percent during entire time of leakage measurements.
4. Leakage Measurement: Do not attempt measurement of leakage until trapped air has been vented and constant test pressure has been established. Measure leakage by means of an approved water meter installed in the pressure piping on discharge of the pump. Ensure that water meter is accurately calibrated.
5. Allowable Leakage: Ensure that pipe reach does not exceed the allowable leakage rate. Calculate allowable leakage with following formula:

   a. Q = 0.0075 DLN where
   b. Q = allowable leakage in gallons per hour
   c. D = nominal diameter of pipe in inches
   d. L = length of section tested in thousand feet (1000-foot maximum)
   e. N = square root of avg test pressure in psi (12.25)

6. Calculate allowable leakage separately for each diameter and add resulting allowable leakage rates to obtain total allowable leakage for entire reach.

E. Drainage and Sanitary Structures and Catch Basins, Leakage Tests:

1. The manholes shall be made as nearly watertight as practicable.
2. The Contractor shall perform leakage tests on each manhole installed using an approved low air pressure testing system. This type of test shall be used only immediately after assembly of the manhole and only prior to backfilling. The manhole to pipe connection should only be a flexible connector. All lift holes shall be plugged with a non-shrinking mortar. For this test, each manhole shall be tested under 10-inch Hg vacuum. The test shall pass if the vacuum remains at 10-inch Hg or drops no lower than 9-inch Hg after 60 seconds for 4 or 5 foot manholes from 0 to 10 feet deep, 75 seconds for 4 or 5 foot manholes from 10 to 15 feet deep, or 90 seconds for 4 or 5 foot manholes from 15 to 25 feet deep. A volume equivalent shall be calculated for larger diameter manholes to determine the testing length based on these parameters.

PART 2 - PRODUCTS

2.1 GENERAL

A. Products used at interface with utility companies shall conform to the requirements of connected utility companies.

2.2 PIPE AND FITTINGS

A. Clay Pipe and Fittings

1. Pipe: ASTM C 700, except crushing strength shall be in accordance with National Clay Pipe Institute Specification ER4, salt or ceramic glazed, bell and spigot except where plain ends are indicated.
2. Joints and Gaskets: ASTM C 425.

B. Plain Concrete Pipe

1. Unperforated: ASTM C14, class as indicated, bell and spigot.
2. Perforated: ASTM C 444, type as indicated, and all applicable requirements of ASTM C 14, class as indicated.

C. Reinforced Concrete Pipe

1. Circular Section: ASTM C 76; ends, class, and wall as indicated.
2. Elliptical Section: ASTM C 507; ends and class as indicated.

D. Joints and Gaskets for Circular Concrete Pipe: ASTM C 443.

E. Cast Iron Culvert Pipe: ASTM A 142.

F. Corrugated Metal Pipe: AASHTO M 36, type and couplings as indicated, coated and paved per ASSHTO M 190, Type C coating and Type A coating for coupling bands.

G. Ductile Iron Pipe for Gravity and Force Mains:

1. Ductile iron pipe shall be that of a United States manufacturer who can demonstrate at least 5 years of successful experience in manufacturing ductile iron pipe. The pipe shall be equipped with push on type, restrained joint, or mechanical joints, as required.
2. All ductile iron pipe shall conform to ANSI/AWWA C 151/A21.51 and ASTM A 746.
3. The ductile iron pipe shall be, at a minimum, Class 52 or as determined considering the trench load and internal pressure separately in accordance with ANSI/AWWA C150/A21.50. Ductile iron pipe shall be H2 Sewer Safe Pipe (Sewper Coat lined).
4. The ductile iron pipe shall be asphalt coated on the outside and inside with a minimum of 1 mil bituminous paint according to ANSI/AWWA C151/A21.51 Section 51-8.1. Prior to the lining, the inside and outside of the spigot end shall be coated with a minimum of 8 mil of epoxy. The inside of the bell end including the gasket cavity shall also be coated with 8 mil of epoxy.
5. The ductile iron pipe lining shall be as manufactured by Lafarge Calcium Aluminates or approved equal. The coating shall be a calcium aluminate mortar consisting of calcium aluminate cement and fused calcium aluminate aggregates. A seal coat shall be applied to the lining. The thickness of the lining shall be 0.125-in for 6-in through 12-in pipe and 0.1875-in for 14-in through 24-in pipe.
6. Gasket Materials: Push-on and mechanical joint gaskets shall be Nitrile (NBR) (Acrylonitrile Butadiene) or equal gasket acceptable for use in an environment which will handle fats, oils and greases unless otherwise noted or approved.
7. Fittings: Fittings shall be compact ductile iron Class 350 Mechanical Joint, conforming to ANSI Specification A21.53 (AWWA C 153), latest edition, for pipe sizes 16 inches and smaller, and Class 350 standard Mechanical Joint fittings conforming to AWWA C110/ANSI A21.10, latest edition except as specified, for pipe sizes 16 through 24 inches, unless specifically stated otherwise in the specifications or on the drawings. Fittings shall be suitable for use with restraints as specified hereinafter. Fittings shall be manufactured in the United States. Fittings shall be of the same material and have the same lining and coating as the pipe specified above. All fittings shall be marked with the weight and shall have distinctly cast upon

them the pressure rating, the manufacturer's identification, nominal diameter of openings and the number of degrees or fraction of the circle on all bends.

a. Caps and plugs installed in all new work as indicated on the drawings shall be provided with a threaded corporation or bleeder valve so that air and water pressure can be relieved prior to future connection.
b. Solid sleeves shall be ductile iron with 350 psi rating. Sleeves shall conform to ANSI/AWWA C 110.

H. Polyvinyl Chloride Pipe:

1. All PVC pipe shall be continuously and permanently marked with the manufacturer's name, pipe size, and pressure rating or stiffness in psi (kpa).
2. The Contractor shall also require the manufacturer to mark the date of extrusion on the pipe. This dating shall be done in conjunction with records to be held by the manufacturer for 2 years, covering quality control tests, raw material batch number, and other information deemed necessary by the manufacturer.
3. Pipe:

   a. All PVC pipe shall be joined by compression joints unless otherwise shown or specified, and shall conform to the following requirements:
   b. Non Perforated Polyvinyl chloride pipe (PVC) shall conform to the requirements of ASTM D 3034, Class SDR 35. Material for PVC pipe shall conform to the requirements of ASTM D 1784 for Class 12454-B or 12454-C as defined therein. All diameters shall be as specified on the Contract Drawings.
   c. Perforated PVC pipe shall conform to the requirements of ASTM D 3034, Class SDR 35. Material for perforated PVC pipe shall conform to the requirements of ASTM D 1784 for Class 12454-B or 12454-C as defined therein. The pipe shall have 3/8 inch perforations, 6 inch on center and 4 holes per row. The pipe shall be 6 inch diameter unless otherwise specified on the Contract Drawings.
   d. Elastomeric seals for compression type joints for PVC pipe and fittings shall conform to the requirements of ASTM D 3212.
   e. Service pipes for storm services shall be a minimum of 8-inches and shall match diameter of existing services for reconnections. Service pipes for sanitary services shall be a minimum of 6-inches and shall match diameter of existing, services for reconnections.
4. Fittings:

   a. All fittings shall conform to the requirements of ASTM D 3034 or ASTM F 679. The ring groove and gasket ring shall be compatible with PVC pipe ends. The flanged fittings shall be compatible with cast-iron or ductile iron pipe fittings.
   b. The strength class of the fittings shall be not less than the strength class of any adjoining pipe.
   c. PVC pipe fittings shall be full-bodied, either injection molded or factory fabricated. Saddle-type tee or wye fittings are not acceptable.

5. Connections:

   a. Sanitary services shall be connected to new, parallel or replacement sanitary sewer lines with full bodied tees or wye fittings.
   b. Storm services shall be connected to new, parallel, or replacement storm sewer lines with full bodied tees or wye fittings for all pipes up to 18-inches in diameter. Connections to pipes larger than 18-inches in diameter or odd sizes shall be made with saddle tap connections, as approved by Engineer.

c. Connections of storm and sanitary service lines to existing storm and sanitary main lines shall be made with full bodied tees or wye fittings wherever possible for existing lines less than 18-inches in diameter and with tapping saddles as approved by Engineer for existing lines greater than 18-inches in diameter and in odd sizes.

6. Gaskets: Flexible elastomeric rings conforming with ASTM F 477.

I. Solid Wall High Density Polyethylene Pipe (HDPE):

1. The HDPE replacement pipe shall be manufactured from a high density, high molecular weight polyethylene resin, which conforms to ASTM D-1248 and meets the requirements for Type III, Class B, Grade P34, Category 5, and has a PPI rating of PE 3408, when compounded. The pipe produced from this resin shall have a minimum cell classification of 345434C or D under ASTM D 3350.
2. The wall thickness of the HDPE pipe shall be as determined by the Contractor for the minimum thickness required to meet the structural requirements listed under Design Criteria below, and shall meet the following:
3. Minimum Wall Thickness: 0-12 feet depth, minimum wall thickness SDR 26; over 12 feet depth, SDR 21 minimum wall thickness.
4. All pipe shall be made of virgin material. No re-work, except that obtained from the manufacturers own production of the same formulation shall be used.
5. The pipe shall be homogenous throughout and shall be free of visible cracks, holes, foreign material, blisters, or other deleterious faults.
6. The interior surface of the HDPE pipe shall not be dark or non-reflective in nature that could inhibit proper television inspection.
7. The finished HDPE pipe shall be continuous over the entire length of an insertion run between the insertion pit and reception pit. The HDPE pipe shall be impervious and free of any leakage from the rehabilitated host pipe to surrounding ground, or from the surrounding ground to the inside of the pipe.
8. The manufacturer of the pipe shall supply the AUTHORITY with certificates of compliance indicating conformance for all material and testing requirements furnished under these Specifications.
9. Each standard pipe unit shall be clearly and permanently marked with the date of manufacture, class, production code, and manufacturer's trademark.
10. The Contractor and manufacturer shall exercise extreme care during transportation, handling, storing, and installation of the HDPE pipe to ensure that the pipe is not gouged or otherwise damaged in any way. The Contractor shall store the pipe with a cover to block ultraviolet light in accordance with the manufacturer's recommendations. If the HDPE pipe becomes gouged or otherwise damaged, before or during installation, it shall be replaced or repaired by the Contractor at no additional cost to the Authority.

J. Centrifugally Cast Fiberglass Reinforced Pipe (FRP):

1. General: Workmanship and methods shall be in accordance with the best practices of modern shops for this type of work and shall be the product of a manufacturing firm having at least five years experience in the manufacture of this type of pipe. Pipe shall have a smooth and even interior surface free from roughness or irregularities. Prior to fabrication of pipe, submit shop drawings showing lengths of pipe, pipe joint details, construction details and tolerances as required by the Authority. Each pipe shall be marked with the date of manufacture, mark or trademark of the manufacturer, and the class, wall thickness of the pipe, and serial number. No slurry mix shall be used on interior of pipe.

2. Resin Systems: The manufacturer shall use only polyester resin systems with a proven history of performance in this particular application. The historical data shall have been acquired from a composite material of similar construction and composition as the proposed product.
3. Glass Reinforcements: The reinforcing glass fibers used to manufacture the components shall be of highest quality commercial grade E-glass filaments with binder and sizing compatible with impregnating resins.
4. Silica Sand: Sand shall be minimum 98% silica with a maximum moisture content of 0.2%.
5. Additives: Resin additives, such as curing agents, pigments, dyes, fillers, thixotropic agents, etc., when used, shall not detrimentally effect the performance of the product.
6. Elastomeric Gaskets: Gaskets shall be supplied by qualified gasket manufacturers and be suitable for the service intended.
7. Pipes, Joints, and Fittings:

    a. Pipe shall be manufactured by the centrifugal casting process to result in a dense, nonporous, corrosion-resistant, consistent composite structure.
    b. Actual outside diameter (18" to 48") of the pipes shall be in accordance with ASTM D 3262. For other diameters, OD's shall be per manufacturer's literature.
    c. Minimum wall thickness shall be the stated design thickness.
    d. Pipe ends shall be square to the pipe axis with a maximum tolerance of 1/8".

8. Unless otherwise specified, the pipe shall be field connected with fiberglass sleeve couplings or bell-spigot joints, "flush" or "non-flush" that utilize elastomeric sealing gaskets as the sole means to maintain joint watertightness. The joints must meet the performance requirements of ASTM D 4161. Joints at tie-ins, when needed, may utilize fiberglass, gaskets-sealed closure couplings.
9. Flanges, elbows, reducers, tees, wyes, laterals, and other fittings shall be capable of withstanding all operating conditions when installed. They may be contact molded or manufactured from mitered sections of pipe joined by glass-fiber-reinforced overlays. Properly protected standard ductile iron, fusion-bonded epoxy-coated steel and stainless steel fittings may also be used.

2.3 STRUCTURAL STEEL FOR SITE ERECTION

A. Corrugated: AASHTO M 167.

B. Flat: AASHTO M 218.

2.4 UNDERDRAIN FILTER

A. Pervious Backfill: Section 02300 - EARTHWORK.

2.5 DRAINAGE AND SANITARY STRUCTURES

A. Precast Manhole and Catch Basin Sections: ASTM C 478.

B. Precast Sections (for non-load bearing drainage structures other than manholes): ASTM C 139.

C. Area Drains shall be cast iron in conformance with Construction Specification Section 05500 and as indicated on the Contract Drawings.

2.6 BRICK

A. ASTM C32, Grade SS, 2-1/4 inches by 3-3/4 inches by 8 inches.

2.7 CONCRETE

A. Concrete, General: Section 03300 - CAST-IN-PLACE CONCRETE.

B. Cradles and Cradle-Arches: Class 4,000-3/4.

C. Manholes and Other Load-Bearing Drainage Structures: Class 4000-3/4.

2.8 CEMENT MORTAR

A. One part Portland cement, two parts sand by volume with sufficient water to form a workable mixture, mortar minimum strength of 3,000 psi.

2.9 FRAMES AND COVERS

A. Frames and covers shall be heavy-duty Type A Massachusetts Standard and conform to the "Standard Specifications for Highways and Bridges", of the Commonwealth of Massachusetts. All frames shall have a minimum clear opening of 30 inches unless otherwise noted.

B. Iron castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow-holes and other defects affecting the strength and value for the service intended. The finished coating shall be tough and tenacious when cold and not brittle or with any tendency to scale off under seasonable temperature changes.

C. Frames and Covers shall be Cast Iron, minimum Class 25 conforming to ASTM A 48, and as follows: Castings to be free from scale, lumps, blisters and sandholes. Machine contact surfaces to prevent rocking. Thoroughly clean and hammer inspect.

D. Frames and covers to be as manufactured by E. L. LeBaron Foundry Co., Neenah Foundry Co., Campbell Foundry Company or equal. Frames and covers shall be capable of withstanding AASHTO H-20 loading unless otherwise indicated or specified.

E. The Contractor shall furnish all manhole frames and covers conforming to the details shown on the drawings, or as herein specified. Frames and covers shall be of cast iron with diamond cover surface design. Manhole covers shall be machined to fit securely and evenly on the frame.

F. Covers for all structures shall have the word "DRAIN", "SEWER"or other appropriate designation cast upon them.

2.10 FRAMES

A. Single Catch Basin Frames shall be as manufactured by E. L. LeBaron Foundry Co., model LK120D for three flange, Neenah Foundry Co., Campbell Foundry Co., or equal.

B. Double Catch Basin Frames shall be as manufactured by E. L. LeBaron Foundry Co., model LV2448-2 with longside flange removed, Neenah Foundry Co., Campbell Foundry Co., or equal.

2.11 GRATES

A. Single and Double Catch Basin Grates shall be cascade type, as manufactured by E. L. LeBaron Foundry Co., model L24SG18, by Neenah Foundry Co., by Campbell Foundry Co., or equal unless otherwise shown on the Drawings.

2.12 HOODS

A. Catch Basin Hoods shall be as manufactured by E. L. LeBaron Foundry Co., model L-202, Neenah Foundry Co., Campbell Foundry Co., or equal.

2.13 NO DUMP CURB MARKERS

A. No-dump markers shall be installed on all existing-to-remain or proposed catch basins and inlets within the project area. Curb markers shall be 4" diameter, 0.090 mil. thick, PVC laminate, with urethane dome, as manufactured by Das Manufacturing Inc., Duracast style.

2.14 FLEXIBLE MANHOLE SEALS

A. Flexible manhole seals shall be "New Lok Joint Flexible Sleeve" by Interpace, "A-Lok Manhole Sleeve" by L & L Concrete Products, "Press Wedge II" by Pre-Seal Basket Corporation, or approved equal. Field applied seals shall be "K or N Seal" boot or equal. Manhole sleeves, gaskets and sealants shall be furnished complete with lubricants, stainless steel stops, inserts, clamps, etc.

2.15 TRENCH DRAINS

A. Provide trench drains and grates as manufactured from one of the following manufacturers, or Engineer approved equal:

1. Neenah Foundry Co.
2. J.R. Smith Manufacturing Co.
3. Zurn

B. Trench Drain Channels: Provide trench drain channels equal to Neenah Foundry Model No. R-4995-A1, or equal by J.R. smith, or Zurn, or approved equal. Each trench drain channel shall have full length horizontal anchoring ribs to mechanically lock the channel into the concrete pavement as indicated on the Drawings.

C. Trench drain grate shall be perforated galvanized steel, heel proof grate conforming to AD and MAAB.

1. Slip Resistant Finish: All trench drains shall be factory coated with an anti-slip, non-gritted, product consisting of a random hatch matrix with a surface hardness of at least 55 on the Rockwell "C" scale and a bond strength to the trench drain of at least 4,000 psi. The

anti-slip surface shall have a minimum coefficient of friction of 0.6 and be listed as slip resistant by UL.

D. Accessories: Provide all necessary outlets, end plates, anchoring components, grate locks, etc. for the complete installation.

2.16 AREA DRAINS

A. Provide area drains and grates as indicated on the Drawings, manufactured from one of the following manufacturers, or Engineer approved equal:

1. Neenah Foundry Co.
2. J.R. Smith Manufacturing Co.
3. LeBaron Foundry Co.

B. Area drain grates shall be heel proof conforming to ADA and MAAB, and be slip resistant.

PART 3 - EXECUTION

3.1 GENERAL

A. Excavation. Excavate trenches as specified in Section 02300 - EARTHWORK.

B. Bedding. Classes of bedding are defined in ASTM C12. Use class of bedding indicated; prepare trench and bedding as specified in ASTM C12. Place concrete for encasement against undisturbed soil.

C. Pipe Laying. Lay all pipe in accordance with the manufacturer's written instructions. Additional requirements for specific types of pipe are included in subsequent articles herein.

D. Structures. Construct manholes, junction chambers, inlets, wingwalls, and other related drainage structures in connection with the installation of pipe. Install or cut pipe flush with the inside face of structure walls.

E. Protection

1. Protect joint materials from the air and sun to prevent drying and other deterioration.
2. Take precautions to prevent flooding of trench prior to backfilling.
3. Do not allow free water to come in contact with pipelines until Portland cement joint and sealing materials have set for at least 24 hours.

F. Backfill. Backfill trenches as specified in Section 02300 - EARTHWORK.

3.2 CRADLES

A. Where gravel, crushed stone, or concrete cradles are indicated, provide bell holes in subgrade to permit uniform cradle depth beneath entire pipe length.

3.3 JACKING PIPE

A. At locations indicated jack reinforced concrete pipe, steel casing pipe, fiberglass reinforced pipe or corrugated metal pipe into place between limits indicated.

B. Strength, reinforcement, and gauge of pipe designated to be jacked will be determined for vertical loads only. Provide additional reinforcement or higher strength or heavier gauge pipe as necessary to withstand jacking pressure, at no additional expense to the Authority.

C. Excavate for jacking pipe not more than 0.1 foot wider than outside limits of pipe. When material tends to cave beyond that limit, use a shield ahead of the first section of pipe. Backfill caving and excavation beyond that limit with sand or grout to fill voids.

D. Sluicing and jetting will not be permitted.

3.4 INSTALLATION OF CORRUGATED METAL PIPE

A. Distortion: When circular pipe 48 inches in diameter and larger is to be placed under fills, distort the pipe for its full length before placing backfill. When specified, distort smaller circular pipe.

1. Distort pipe from a true circle to increase the vertical diameter by approximately three percent through the full length.
2. Pipe may be distorted either in the shop or in the field. If pipe is to be distorted in the field, use one of the following methods:

    a. By mechanical pressure sufficient to introduce a permanent distortion in pipe; or
    b. By distorting assembled pipe and retaining distortion by means of rods, wires, struts, or other means.

B. Placement: Lay distorted circular pipe with major axis vertical. Maintain rods, wires, struts, or other means used to maintain distortion in place until completion of backfill or embankment, but remove prior to construction of headwalls and other structures at ends of pipe.

C. Joining: Join sections of pipe with corrugated metal bands. Do not damage protective coating when tightening bolts. After final tightening, apply brush coat of bituminous paint to bands and bolts.

3.5 INSTALLATION OF REINFORCED CONCRETE PIPE

A. Placement: Lay pipe upgrade with bell or groove end uphill. Place circular pipe having elliptical reinforcement with minor axis of the reinforcement in vertical position.

B. Backfilling: Except where an exfiltration/infiltration test is to be performed, backfill of culvert-pipe and siphon-pipe trenches may be completed while joint mortar is still plastic. Should joint mortar become set before placing backfill, do not commence backfilling within 16 hours of joining pipe sections.

3.6 INSTALLATION OF DUCTILE IRON PIPE

A. Handling Pipe: 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. Pipe shall be stored above ground at a height no greater than 5 feet, and with even support for the pipe barrel. Only nylon protected slings shall be used for handling the pipe. No hooks or bare cables will be permitted. Gaskets shall be shipped in cartons and stored in a clean area, away from grease, oil, heat, direct sunlight and ozone producing electric motors.

B. Alignment and Placement of Pipe: Jointing of ductile iron pipe and fittings shall be done in accordance with the printed recommendations of the manufacturer and as specified. The last 8 inches of the outside of the spigot end of pipe and the inside of the bell end of pipe shall be thoroughly cleaned. The joint surfaces and the gasket shall be painted with a lubricant just prior to making up the joint. The spigot end shall then be gently pushed home into the bell. The position of the gasket shall be checked to insure that the joint has been properly made and is watertight. Care shall be taken not to exceed the manufacturer's recommended maximum deflection allowed for each joint.

C. Installation and jointing of push-on ductile iron pipe shall be in accordance with AWWA C 600 Sections 9b and 9c, latest revision, as applicable. Mechanical joints shall be installed with Mega-Lug, Uni-Flange or MJR restraints. Restraints shall be installed in full accordance with the manufacturers' instructions. All bolt heads on Mega-Lugs or Uni-flanged shall be tightened sufficiently so that they shear off to provide indication that proper tightening torque was achieved. MJR systems shall be installed with ductile iron locking ring, tapered MJ gland and a symmetrical locking ring. Restrained push on joints shall be installed with specified gasket joint restraints. Restraints shall be installed in full accordance with the manufacturers' instructions. Fittings and valves shall be restrained as shown on the drawings.

D. Piping Support: Furnish and install supports to hold piping at lines and grades indicated or specified. Support pipe and appurtenances connected to equipment to prevent any strain imposed on equipment.

E. Pipe and Fittings: Remove and replace defective pieces. Clear of all debris and dirt before installing and keep clean until accepted. Lay accurately to lines and grades indicated or required. Provide accurate alignment, both horizontally and vertically. Provide firm bearing along entire length of buried pipelines.

F. Appurtenances: Set valves, fittings and appurtenances as indicated.

G. Push-on Joints: Insert gasket into groove bell. Apply thin film of nontoxic gasket lubricant over inner surface of gasket in contact with spigot end. Insert chamfered end into gasket. Force pipe past it until it seats against socket bottom. Where required install restraint and secure in accordance with manufacturer's instructions.

H. Mechanical Joints: Wire brush surfaces in contact with gasket and clean gasket. Lubricate gasket, bell, and spigot with soapy water. Slip gland and gasket over spigot, and insert spigot into bell until seated. Seat gasket and press gland firmly against gasket. After bolts inserted and nuts made finger-tight, tighten diametrically opposite nuts progressively and uniformly around joint by torque wrench. Torque bolts to values specified above.

I. Testing: Clean of all dirt, dust, oil, grease and other foreign material, before conducting pressure and leakage tests.

3.7 INSTALLATION OF PVC PIPE

A. Each pipe unit shall be inspected before being installed. No single piece of pipe shall be laid unless it is generally straight. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than 1/16 inch per foot of length. If a piece of pipe fails to meet this requirement for straightness, it shall be rejected and removed from the site. Any pipe unit or fitting discovered to be defective, either before or after installation, shall be removed and replaced with a sound unit.

B. No pipe or fitting shall be permanently supported on saddles, blocking, or stones. Crushed stone shall be as specified in Section 02300 - EARTHWORK.

C. Suitable bell holes shall be provided, so that after placement, only the barrel of the pipe receives bearing pressure from the supporting material. Special care shall be taken to hold the trench width at the crown of the pipe to the maximum indicated on the Trench Detail included in the Details Section of these specifications.

D. All pipe and fittings shall be cleared of all debris, dirt, etc., before being installed and shall be kept clean until accepted in the completed work.

E. Pipe and fittings shall be installed to the lines and grades indicated on the Drawings. Care shall be taken to ensure true alignments and gradients.

F. Before any joint is made, the previously installed unit shall be checked to assure that a close joint with the adjoining unit has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to the required grade by striking it with a shovel handle, timber or other unyielding object.

G. All joint surfaces shall be cleaned. Immediately before jointing the pipe, the bell or groove shall be checked to see that the rubber ring is properly seated. Apply lubricant to the spigot end only, paying particular attention to the bevel, in accordance with the manufacturer's recommendation. Each pipe unit shall then be carefully pushed into place without damage to pipe or gasket. Suitable devices shall be used to force the pipe units together so that they will fit with minimum open recess inside and outside and have tightly sealed joints. Care shall be taken not to use such force as to wedge apart and split the bell or groove ends. Joints shall not be "pulled" or "cramped" unless permitted by the Engineer.

H. Where any two pipe units do not fit each other closely enough to enable them to be properly jointed, they shall be removed and replaced with suitable units and new gaskets.

I. Details of gasket installation and joint assembly shall follow the directions of the manufacturers of the joint materials and of the pipe, all subject to review by the Engineer. The resulting joints shall be watertight and flexible.

J. All premolded gasket joint polyvinyl chloride pipe of a particular manufacturer may be rejected if there are more than five unsatisfactory joint assembly operations or "bell breaks" in 100 consecutive joints, even though the pipe and joint conform to the appropriate ASTM Specifications as hereinbefore specified. If the pipe is unsatisfactory, as determined above, the Contractor shall, if required, remove all pipe of that manufacturer of the same shipment from the work and shall furnish pipe from another manufacturer which will conform to all of the requirements of these specifications.

K. Open ends of pipe and branches shall be closed with polyvinyl chloride stoppers secured in place in an acceptable manner.

L. After each pipe has been properly bedded, enough crushed stone shall be placed between the pipe and the sides of the trench, and thoroughly compacted, to hold the pipe in correct alignment. Bell holes, provided for jointing, shall be filled with crushed stone and compacted, and then crushed stone shall be placed and compacted to complete the pipe bedding.

M. The Contractor shall take all necessary precautions to prevent flotation of the pipe in the trench. At all times pipe installation is not in progress, the open ends of the pipe shall be closed with temporary watertight plugs, or by other acceptable means.

N. If water is in the trench when work is to be resumed, the plug shall not be removed until suitable provisions have been made to prevent water, earth, or other substances from entering the pipe. Pipelines shall not be used as conductors for trench drainage during construction. Install PVC pipe and fittings in accordance with manufacturer's printed instructions.

O. Allowable Pipe Deflection: Pipe provided under this Specification shall be so installed as to not exceed a maximum deflection of 5.0 percent. Such deflection shall be computed by multiplying the amount of deflection (nominal diameter less minimum diameter when measured) by 100 and dividing by the nominal diameter of the pipe. Upon completion of a section of pipe, including placement and compaction of backfill, the Contractor shall measure the amount of deflection by pulling a specially designed gage assembly through the completed section. The gage assembly shall be in accordance with the recommendations of the pipe manufacturer, and be reviewed by the Engineer. The section of pipe must be placed and backfilled for a minimum of 90 days before the deflection can be measured. Should the installed pipe fail to meet this requirement, the Contractor shall do all work to correct the problem without additional compensation.

P. 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 pipe.

3.8 INSTALLATION OF FRP PIPE

A. General: Installation of pipe and fittings shall be in accordance with the project plans and specifications and the manufacturer's requirements. In addition, installation of piping shall be in accordance with governing authorities having jurisdiction, except where more stringent requirements are indicated.

B. Handling Pipe: Textile slings, other suitable materials or a forklift shall be used in the handling of pipes. Use of chains or cables is not recommended. 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.

C. Laying Pipe: Except where a concrete cradle or envelope is required, all pipe shall be laid in crushed stone. 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.

D. Jointing Pipe: After the pipe are aligned in the trench and are ready to be jointed, the following shall be performed: Ends of pipe and coupling components shall be cleaned. Joint lubricant shall be applied to pipe ends or bell interior surfaces and the elastomeric seals. Only lubricants approved by the pipe manufacturer shall be used. Suitable equipment and end protection to push or pull the pipes

together shall be used. Recommended forces by the manufacturer for joining or pushing pipe shall not be exceeded. Pipes shall be joined in straight alignment and then deflected to required angle. Deflection angle shall not exceed the deflection permitted by the manufacturer.

E. 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.

F. 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 Drain. Place plugs in end of uncompleted conduit at end of day or whenever work stops. Flush lines between manholes if required to remove collected debris.

3.9 CONCRETE ENCASEMENT

A. If pipe is indicated to be entirely or partly embedded in concrete, support and brace pipe in a manner that will prevent movement or displacement of pipe during testing and during placement and consolidation of concrete.

B. Place concrete as specified in Section 03300 - CAST-IN-PLACE CONCRETE, being careful to tamp concrete under and around pipe without displacing pipe.

C. Do not use earth form.

3.10 BACKFILL

A. Partial Backfill Before Testing

1. Deposit and compact backfill in four inch layers around bottom half of pipe and for full width of trench, leaving top half of pipe exposed.
2. Deposit and compact additional backfill between joints, to a depth of 12 inches above top of pipe, leaving joints exposed.

B. Final Backfill After Testing

1. Backfill and compact as specified in Section 02300 - EARTHWORK, flush with finished grade. If permitted by the Engineer, surface of backfill may be slightly convex.
2. Restore surface to its original condition or as required.

3.11 LEAKAGE TOLERANCES

A. Gravity Lines. Maximum allowable leakage for any section or sections, or for the total lengths of pipe lines: 200 gallons per inch of diameter per mile per 24 hours.

B. Force Mains: Zero leakage in 30 minutes at 150 percent of the maximum pressure that pump or ejector is capable of developing.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Pipe will be measured by the linear foot for each type and size, along the center line with deduction made for manholes, inlets or other drainage structures measured from the inside face of each structure.

B. Drainage and sanitary sewer structures will be measured per each type and size built.

C. Items including: pipe fittings, joints, excavation, protective coatings, manhole steps, 6-inch drainage connection stubs through drainage structures, cleanouts, collar taps and cutting of pipes, manholes and inlet bases will not be separately measured and all costs in connection therewith will be considered incidental to the item of work to which they pertain.

D. Concrete for encasement for drainage systems shall not be measured separately but shall be included in the item or items of work to which it pertains.

E. Catch Basin Type 'A' and Precast Drain Manholes shall be measured per each, and shall include excavation, backfill, frames and grates or covers, and all accessories and incidentals necessary to complete the item.

F. Catch Basins or Manholes Removed and Utility Structures Adjusted shall be measured in accordance with Section 02650 - EXISTING SITE UTILITIES.

G. Allowances for Acton Water and Sewer Commission inspection services shall be measured in accordance with Section 01020 - ALLOWANCES.

H. Frames and Grates or Covers for drainage structures shall not be measured separately, but shall be included in the item of work to which it pertains.

I. Frames and Grates or Covers Remove and Reset shall be measured per each frame and grate or cover reset.

4.2 PAYMENT

A. Reinforced Concrete Pipe shall be paid for at the Contract unit price per linear foot of pipe installed by size. Ductile iron pipe shall be paid for at the Contract Unit price per linear foot for drainage and sewerage of pipe installed by size. 8 inch ductile iron pipe shall be paid for at the Contract Unit Price per linear foot of cast iron drainage pipe installed. Payment shall be full compensation for all labor, materials and equipment required to install pipes in the sizes and types indicated on the Contract Documents.

B. Catch basins and Drain Manholes shall be paid for at the Contract unit price per each. Payment shall be full compensation for all labor, materials and equipment required to install manholes. Payment shall include but not be limited to hoods where required, concrete collars, flexible rubber collars, masonry and mortar as required to adjust frame to grade, steps and ladders and the pre-cast manhole structure.

C. Frame and Grate or Cover Remove and Reset shall be paid for at the Contract unit price per each. Payment shall be full compensation for all labor, materials and equipment required to install new

frames and grates or covers; or remove and relocate existing frames and grates or covers at location shown on the Contract Documents.

D. Catch Basins or Manholes Removed shall be paid for in accordance with Section 02650 - EXISTING SITE UTILITIES.

E. Payment for Acton Water and Sewer Commission services will be made as specified in Section 01020 - ALLOWANCES.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0222.522	PRECAST DRAIN MANHOLE	EA
0222.542	FRAMES AND GRATES OR COVERS REMOVE AND RESET	EA
0250.094	CATCH BASIN TYPE A	EA
0250.118	CATCH BASIN OR MANHOLE ADJUSTED	EA
0251.115	15" PERF. ACCM PIPE	LF
0251.591	8" PVC PIPE	LF
0348.415	15" REINFORCED CONCRETE PIPE CLASS IV	LF
----------	30" REINFORCED CONCRETE PIPE CLASS IV	LF

END OF SECTION

SECTION 02444

CHAIN-LINK FENCE

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies the furnishing and installation of chain-link fence and gates of Type IV: Colored PVC-Coated Steel Fabric with Galvanized and Factory-Painted Steel Posts, Hardware, and Fittings.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 03300 - CAST-IN-PLACE CONCRETE
2. Section 05500 - MISCELLANEOUS METALS
3. Section 09900 - PAINTING
4. Section 16450 - GROUNDING.

1.2 SUBMITTALS

A. Shop Drawings:

1. Include cross sectional dimensions of posts, braces, rails, fence fabric, fittings, accessories and gate frames; design of gates; and details of all gate hardware.
2. Include a layout drawing showing the spacing of posts and location of all gates; abrupt changes in grade; and all corner, gate, anchor, end, and pull posts.
3. Provide vinyl color choices for selection for each location.

B. Certificates. Submit certified test reports giving results of tests specified herein for zinc and vinyl coatings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with AASHTO M181, with the additions and modifications specified herein.

1. Aluminum alloy line, end, and corner posts, and top rail, may be substituted for galvanized steel at the Contractor's option.
2. Aluminum Alloy: ASTM B221 for shapes, and B429 for pipe, Alloy 6061-T6. Pipe dimensions specified are the nominal pipe sizes per ASTM B429 Schedule 40 except Schedule 80 dimensions and weights shall be used in areas where pedestrian traffic is adjacent to the fence line. Coat portions of posts to be embedded in concrete with two coats of an accepted coal-tar mastic, allowing 24 hours drying time between coats.

3. Steel pipe dimensions and weights: ASTM A120, Schedule 40 except Schedule 80 dimensions and weights shall be used in areas where pedestrian traffic is adjacent to the fence line. Dimensions specified are the nominal pipe sizes.
4. Dimensions and weights specified herein are subject to a tolerance of plus or minus five percent.
5. Zinc Coating: Minimum 2.0 ounces per square foot except where specified otherwise.
6. Provide posts with accepted tops of same material as posts, so designed as to fit securely over post and carry top rail or cable; the base of top fitting shall carry an apron around outside of post.

B. Line Posts

1. Steel, Five Feet and Shorter: 1-1/2 inch pipe; or 1.625 by 1.875 inch H column weighing 2.70 pounds per foot; or 1.625 by 1.875 inch C column weighing 2.20 pounds per foot.
2. Aluminum, Five Feet and Shorter: 1.625 by 1.875 inch H column weighing 1.03 pounds per foot.
3. Steel, Over Five Feet: 2 inch pipe; or 1.95 by 2.25 inch H column weighing 4.10 pounds per foot; for 1.70 by 2.25 inch C column with a weight of 2.66 pounds per foot.
4. Aluminum, Over Five Feet: 2 by 2.25 inch H column weighing 1.24 pounds per foot.

C. Gate Posts: Steel, minimum 3-1/2 inch pipe, except as otherwise specified in the Construction Specifications.

D. End and Corner Posts

1. Steel, Five Feet and Shorter: 2 inch pipe, or 3.5 inch square C column weighing 5.163 pounds per foot.
2. Aluminum, Five Feet and Shorter: 2 inch pipe.
3. Steel, Over Five Feet: 2.5 inch pipe, or 3.5 inch square C column weighing 5.163 pounds per foot.
4. Aluminum, Over Five Feet: 2.5 inch pipe.

E. Top Rail, Cables, and Spring Tension Wire

1. Top Rail
   a. Steel: 1-1/4 inch pipe, or 1.25 x 1.625 inch C section weighing 1.262 pounds per foot.
   b. Aluminum: 1.25 inch pipe.
   c. Couplings and Expansion Sleeves: Outside sleeve type, minimum six inches long.
2. Cable: ASTM A475, 3/8 inch, seven-strand, common grade, Class A galvanizing.
3. Cable attachments
   a. Shoulder Eye Bolts: 5/8 inch diameter, of sufficient length to fasten to the post used.
   b. Turnbuckles: Shackle end type, 1/2 inch diameter, with six-inch standard take-up and 3/8 inch diameter pins.
   c. Thimbles: lightweight wire rope for use with 3/8 inch diameter cable
   d. Wire Rope Clips: U-bolt diameter of 7/16 inch for use with 3/8 inch diameter cable.
   e. Anchor Shackles: 3/8 inch diameter, 11/16 minimum distance between eyes, 7/16 inch pin diameter.
   f. Seizing: 0.0181 inch diameter galvanized annealed iron wire.
4. Spring Tension Wire: Coil spring steel, 0.1770 inch diameter; base metal having a minimum tensile strength of 80,000 psi, galvanized with 1.6 ounces per square foot; or aluminum coated with 0.4 ounces per square foot.

F. Braces and Tension Rods

1. Compression Braces: Same type and size as top rail.
2. Tension Rods: 3/8 inch round rods with drop-forged turnbuckles or other approved type of adjustment.

G. Fence Fabric

1. Type I, Galvanized Steel: ASTM A392, Size 9, Class 2 coating.
2. Type II, Aluminum-Coated Steel: ASTM A491, Size 9.
3. Type IV, PVC-Coated Steel: ASTM A392, Size 9, except with PVC coating in lieu of galvanizing.
4. Selvages, all Types
   a. Fabric 60 inches high and under: knuckled at both selvages.
   b. Fabric over 60 inches high: knuckled at one selvage and twisted and barbed at the other.

H. Fabric Band and Stretcher Bars

1. Fabric Band: Minimum 1/8 by 3/4 inch section.
2. Stretcher Bars: Minimum 1/4 by 3/4 inch section.
3. Aluminum Alloy Items: ASTM B221, 6061-T6.

I. Tie Wire and Miscellaneous Items

1. Tie Wire: Galvanized or aluminum-coated 0.148 inch steel wire, or aluminum alloy conforming to ASTM B211, 1100-H14.
2. Hog Rings: Galvanized or aluminum-coated 0.120 inch steel wire, or aluminum conforming to ASTM B221, 6061-T6. Aluminum coating: minimum 0.24 ounces per square foot.
3. Post Clips: Galvanized or aluminum-coated 0.192 inch steel wire, or aluminum alloy conforming to ASTM B211, 1100-H14. Aluminum coating: minimum 0.30 ounces per square foot.

J. Barbed Wire and Extension Arms

1. Barbed Wire will not be used.
2. Extension Arms will not be used.

K. Gates

1. General. Furnish gates complete with necessary hinges, latches, and drop bar locking devices; corners shall be welded or fastened and reinforced with suitable fittings.
2. Gates Frames, Six Feet and Under: 1-1/4 inch steel pipe or aluminum tubing.
3. Gate Frames, Over Six Feet; 1-1/2 inch steel pipe or aluminum tubing.
4. Cross-Trussing: 3/8 inch galvanized iron adjustable rods.

L. Concrete: Section 03300 - CAST-IN-PLACE CONCRETE, Class 4000, 3/4.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Place posts at each corner, change of direction, abrupt change in grade, gate, and terminal, in addition to line and pull posts.

B. Space line posts on not more than 10-foot centers. In determining the posts spacing, measure parallel to slope of finished grade. Place all posts in vertical position.

C. Where fencing is installed on the top of concrete structures, use galvanized sleeve and grout posts. Set all other posts permanently in concrete.

D. Coat aluminum posts with material specified for protection of dissimilar metals as specified in Section 05500 - MISCELLANEOUS METALS, from bottom to two inches above concrete prior to embedment, and touch-up such coated areas in accordance with requirements of Section 09900 - PAINTING, after concrete is cured. Similarly protect bottoms of aluminum anchor plates that will be in contact with concrete.

E. Excavate post hole footings not smaller than 12 inches in diameter and 36 inches deep. Crown top of concrete to shed water, and allow to cure not less than 72 hours before proceeding with further work on the posts. Backfill posts with acceptable material placed in layers and thoroughly compacted. Embed galvanized steel eye bolts in the top of footings, adjacent to the posts, to receive the bottom tension wire.

F. Brace end, corner, pull, and gate posts to the nearest line post, with diagonal or horizontal brace rails used as compression members, and with truss rods with turnbuckles used as tension members. Brace line posts horizontally and truss in both directions as required, at approved intervals.

G. Fasten fabric to outer face of posts, except where a property owner's existing fencing occurs directly against and adjacent to the Authority's fencing, fasten chain-link fabric to the inner face of posts. Stretch and securely fasten fabric to posts, rails, and top and bottom tension wire with either tie wires or metal bands. Stretch tension wires tight with turnbuckles spaced at not more than 1,000 foot intervals. Install bottom tension wire on straight grade between posts by excavating the high points of ground; in no case will filling of depressions be permitted. Fasten fabric to end, corner, pull, and gate posts with stretcher bar bands spaced at one foot intervals. Place fasteners at approximately 14 inch intervals on pipes and at approximately 18 inch intervals on tension wires. Insure that the bottom tension wire is installed so that the fence fabric selvage is not more than one inch from the surface of the ground or top of concrete, except where special closures at ground depressions are indicated. Run the bottom tension wire through eye bolts installed in the footing or top of wall at each post.

H. Barbed wire will not be used.

I. Provide steel angle metal closures where finish ground surface is more than one inch below the bottom tension wire. Bolt steel angle to fence posts, and install the reinforcing rods and bracing members as approved. Install rods of accepted length vertically. Where drainage ditches cross the fence line, provide concrete ditch lining and steel reinforcing bar grille.

J. Electrical Ground. Where a power line carrying more than 600 volts passes over fence, install ground rod at the nearest point directly below each point of crossing. Ground all substation fences and gates and perform other electrical grounding as indicated and as specified in Section 16450 - GROUNDING.

3.2 TOUCH-UP AND REPAIR WORK

A. Remove and replace fencing which is improperly located or is not true to line, grade and plumb within tolerances as indicated.

B. Repair damaged vinyl-coated components as recommended by the manufacturer.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Chain-link fence will be measured by the linear foot of each type and height complete in place, parallel to finished grade from center to center of end posts.

B. Gates will be included as part of the linear foot measurement of chain link fence.

C. Electrical grounding will be measured and paid for as specified in Section 16450 - GROUNDING.

D. Earthwork, drilling, sleeves, grout and concrete, metal closures to ground, and other items associated with the installation work will not be separately measured and paid for, but all costs therefore will be considered incidental to chain-link fence and gates.

4.2 PAYMENT

A. Chain-link fence and gates will be paid at the Contract unit price for the quantities determined as specified above.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0271.101	48" CHAIN LINK FENCE VINYL COATED	LF
0271.103	72" CHAIN LINK FENCE VINYL COATED	LF

END OF SECTION

SECTION 02451

GUARD RAIL

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies furnishing and installing steel beam type highway guardrail.

1.2 SUBMITTALS

A. Product Data: Provide manufacturers' literature complete describing products.

B. Shop Drawings:

1. Include cross sectional dimensions of posts, rail elements, and terminal sections.
2. Include layout drawing showing spacing of posts; abrupt changes in grade; and all rail and terminal sections.

C. Certificates: Provide certificate certifying compliance of materials with standards designated.

1.3 QUALITY ASSURANCE

A. Erect guardrail true to line and grade and to dimensions conforming to Contract Drawings and manufacturers' instructions and recommendations.

PART 2 - PRODUCTS

2.1 STEEL POSTS

A. Fabricated from ASTM A36 steel "H" sections and channels as indicated; hot-dip galvanized per ASTM A123, and stamped with the ASTM number and the weight of the zinc coating in ounces per square foot.

2.2 RAIL ELEMENT AND TERMINAL SECTIONS

A. AASHTO M180, Class A, Type 2. Fit each end of the rail, for each stretch of guard, with a terminal section as indicated, using the same splice detail as for the rail. Provide shapes and profiles indicated on the Drawings.

2.3 BOLTS, NUTS, WASHERS

A. ASTM A307, galvanized per ASTM A153.

2.4 TOUCH-UP PAINT

A. Provide touch-up paint meeting requirements of paint as specified in Section 09900 - PAINTING.

2.5 FABRICATION

A. Fabricate all metal work in the shop. Do not punch, cut, or weld in the field. Where holes are required to be made in the field, drill such holes.

B. Galvanize components of bolted assemblies separately before assembly. When necessary to straighten sections after galvanizing, perform such work without damage to the zinc coating.

PART 3 - EXECUTION

3.1 ERECTION

A. Posts:

1. Posts may be driven or set plumb in hand or mechanically-dug holes; then backfill with suitable material placed in layers and thoroughly compacted.
2. When driving posts, use suitable caps and equipment which will not batter or injure the posts. Remove and replace posts damaged or distorted by driving.
3. Where posts are to be set in areas of proposed bituminous concrete surfacing, erect posts prior to laying the surrounding finished surface.

B. Rail:

1. Erect rail so as to form a smooth continuous rail conforming to the required line and grade. Splice rail by lapping in the direction of traffic. Holes in the rail element nearer the posts shall be slotted to facilitate erection and permit expansion. Rail shall make full contact at each splice.
2. Draw bolts tight except at expansion joints. At expansion joints, draw bolts as tightly as possible without preventing the rail elements from sliding past each other longitudinally.

C. Touch-Up of Damaged Surfaces: Touch-up damaged galvanized surfaces in accordance with requirements of Section 09900 - PAINTING.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Single-faced and double-faced guard rail will each be measured by the linear foot along the top edge of the rail complete in place, from center to center of end posts, including all posts and fasteners.

B. Single-faced and double-faced terminal sections will be measured by the number of units complete in place.

4.2 PAYMENT

A. Guardrail and terminal sections will be paid for at the Contract unit prices for the quantities determined as specified above.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0261.020	GUARD RAIL	LF
0261.021	TERMINAL SECTIONS FOR GUARD RAIL	EA

END OF SECTION

SECTION 02470

SITE IMPROVEMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies furnishing and installation of miscellaneous site improvements including bicycle racks, exterior benches (outside the limits of the station platforms), protective posts, trash receptacles, and wood guard rail.

B. Concrete, concrete reinforcement, miscellaneous metals and incidentals thereto shall conform to the applicable requirements of Standard Specifications, 02200, 03100, 03200, 03300, 03310, 03604, 05041 and 05500, as modified herein.

1.2 SUBMITTALS

A. Shop Drawings

1. Submit shop drawings and samples for the bicycle racks for review and approval prior to fabrication.
2. Submit shop drawings including catalog cuts and literature for benches.
3. Submit shop drawings for bollards.
4. Submit detailed shop drawings of product including overall dimensions and options including catalog cuts, literature and full range of material samples for color selection for trash receptacles.
5. Submit shop drawings for wood guard rail.

PART 2 - PRODUCTS

2.1 BICYCLE RACKS

A. The bicycle racks shall be heavy duty high quality steel, with mainframe C.R.W. 2-3/8 inch diameter H.S 3/4, as shown on the Contract Drawings. Finishes shall be stainless steel, galvanized steel, or plastic color coated carbon steel. The bicycle rack shall provide lock supports per ASTM A-36 ¾" H.R. Roundbar. The bicycle racks shall be manufactured by Cora Expo, or approved equal. The entire rack shall be galvanized after fabrication.

B. Concrete footings shall be Class 4000.

C. All hardware shall be fabricated from steel and galvanized after fabrication.

2.2 BENCHES

A. Benches shall be made of IPE wood, as indicated in Specification Section 06100, with concrete foundations, located as shown on the Drawings.

2.3 BOLLARDS

A. Provide removable bollard with foundation as indicated on the Drawings and on approved shop drawings.

2.4 TRASH RECEPTACLES

A. Trash Receptacles: Provide 12 gauge galvanized steel trash receptacles, 26 inches square by 40 inches high, with four 5-inch by 21 ¾-inch side receptacle openings at the top; lid locks; 4-inch kick plates; and 12 gauge 4-inch long steel legs with levelers. Provide units complete with retainer bands for holding trash bags, automatic lid locks (all units keyed alike), and with manufacturer's standard anchoring kit for anchoring units to concrete substrates.

1. Exterior shall be manufacturer's standard painted finish, grey color with white "PITCH-IN" decal applied to two opposite sides, and black on white MBTA "T" decal applied to the other two sides.

B. Capacity: 36 gallons.

C. All hardware shall be stainless steel conforming to AISI Type 304 ad ASTM A193 latest requirements. Anchor bolts shall be sized as indicated on the Drawings

2.5 WOOD GUARD RAIL

A. Wood Guard Rail posts, beams, hardware, and accessories shall be as indicated on the Drawings.

PART 3 - EXECUTION

3.1 BICYCLE RACKS

A. Work shall be executed only by workmen experienced in the trade.

B. Obtain exact dimensions, cut, fit and drill as necessary for proper assembly and installation of all work and for attaching items of other trades as required.

C. The bending method for the rack pipe shall produce a smooth curved pipe without surface buckles, dents, and wrinkles and without excessive thinning of pipe walls.

D. All steel fabrication, including any welding and dressing, shall be completed before galvanizing.

E. Welding shall conform to the applicable requirements of AWS D1.1. All groove welds shall be ground flush and smooth.

F. Install racks level and plumb at the locations indicated on the Contract Drawings and in accordance with approved shop drawings. Coordinate rack installation with installation of the surrounding surface at grade beneath the racks until adjacent work is completed. Repair all damage to the finish in a manner consistent with the manufacturer's recommendations.

G. Protect racks from paint spatter, splashed concrete and other construction damage by wrapping and taping in place plastic sheeting or heavy kraft paper around the racks until adjacent work is completed. Repair all

damage to the painted finish in manner consistent with the manufacturer's recommendations and with the original bicycle rack paint.

3.2 BENCHES

A. Benches shall be mounted as recommended by the manufacturer and as shown on the drawings and approved shop drawings.

B. Shim benches as necessary with stainless steel shims to install level and plumb.

3.3 BOLLARDS AND POSTS

A. Bollards and posts shall be set plumb in hand or mechanically-dug holes; then backfilled with suitable material placed in layers and thoroughly compacted. Align posts to the lines and grades indicated on the Plans. Place posts in a vertical position at the same height.

B. Removable bollards shall be installed as indicated on the drawings, as recommended by the approved supplier, and as directed.

3.4 TRASH RECEPTACLES

A. Preparation: Lay out units in the field for approval from the Engineer for precise location prior to installation.

B. Installation: Permanently mount unit to substrate with 3/4" square anchor bolt.

C. Protection: Provide temporary protection for completed work until final acceptance. Remove protections and re-clean as necessary, immediately before final acceptance.

3.5 WOOD GUARD RAILS

A. Wood guard Rail shall be installed as indicated on the Drawings.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Benches with display signs, windscreens, etc., along the station platforms and access walkways, will not be measured separately, but will be considered incidental to the items of work to which they pertain.

B. Benches that are not connected with display signs will be measured per each complete in-place, including excavation, backfill, concrete base foundation, and furnishing all labor, materials, equipment and incidentals necessary to satisfactorily complete the work.

C. Bicycle Racks will be measured per each complete in-place, including excavation, backfill, compaction, cast-in-place concrete foundation, steel pipe and furnishing all labor, materials, equipment and incidentals necessary to satisfactorily complete the work

D. Protective posts will be measured per each complete in-place, including excavation, backfill, concrete foundation, and furnishing all labor, materials, equipment and incidentals necessary to satisfactorily complete the work.

E. Trash receptacles will be measured for each trash receptacle furnished and installed, complete in place, including all incidentals.

F. Wood guard rail will be measured per linear foot complete in-place, including excavation, backfill, concrete foundation, and furnishing all labor, materials, equipment, and incidentals necessary to satisfactorily complete the work.

4.2 PAYMENT

A. Payment for Benches, Bicycle Racks, Protective Posts, Trash Receptacles, and Wood Guard Rail will be made at the Contract unit prices for the quantities determined as specified above.

4.3 PAYMENT ITEMS

Item No.	Description	Unit
0422.005	PROTECTIVE POST	EA
1050.270	BENCHES – EXTERIOR	EA
1098.020	TRASH RECEPTACLE	EA
1112.000	BICYCLE RACK	EA
0261.020	GUARD RAIL	LF

END OF SECTION

SECTION 02513

BITUMINOUS CONCRETE PAVEMENT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies the construction of bituminous concrete pavement on prepared subgrade or aggregate subbase or base course, on bridges, and on existing pavement, to the lines, grades, compacted thickness, and cross sections indicated.

1.2 QUALITY ASSURANCE

A. Job Mix Formulae

1. The composition limits specified in Table 02513-C at the end of this Section are master ranges of tolerances of materials in general. In order to obtain standard texture, density, and stability, furnish to the Engineer for approval a specific job mix formula for the particular uniform combination of materials and sources of supply to be used on each project. Establish the job mix formula in accordance with the requirements of the Massachusetts Highway Department Section M3 Standards.
2. Should a change of sources of materials be made, furnish a new job mix formula for approval before using the new material.
3. Two or more job mix formulae may be approved for a particular plant; however, only material conforming to one job mix formula will be permitted to be used on any given day. If the Contractor elects to furnish bituminous concrete from more than one plant, the job mix formulae shall be adhered to by all plants.
4. When unsatisfactory results or other conditions make it necessary, the Engineer may establish new job mix formulae.

B. Methods of Sampling and Testing

1. Performance Graded Asphalt Binder
   a. Viscosity: ASTM D4402.
   b. Dynamic Shear: AASHTO TP5.
   c. Flash Point: AASHTO T48.
   d. Rolling Thin Film Over Test: AASHTO T240.
   e. Mass Change %: AASHTO T240.
   f. PAV Aging: AASHTO PP1.
   g. Specific Gravity: ASTM D 3142.
   h. Creep Stiffness and M-Value: AASHTO TP1.
2. Cutback Asphalt
   a. Viscosity: ASTM D 2170.
   b. Flash Point: ASTM D 3143.
   c. Distillation: ASTM D 402.
   d. Water in Asphalt: AASHTO T55.
   e. Specific Gravity: AASHTO T228.
3. Emulsified Asphalt: ASTM D 977.

4. Mineral Aggregates and Filler:
   a. Sieve Analysis, Aggregates: ASTM C 136.
   b. Sieve Analysis, Mineral Filler: ASTM D 242.
   c. Unit Weight of Aggregate: ASTM C 29.
   d. Material Passing No. 200 Sieve: ASTM C 117.
   e. Abrasion of Coarse Aggregate: ASTM C 131.
   f. Soundness of Aggregates: ASTM C 88.
   g. Specific Gravity, Coarse Aggregate: ASTM C 127.
   h. Specific Gravity, Fine Aggregate: ASTM C 128.
   i. Specific Gravity, Mineral Filler: AASHTO T100 to T133
5. Bituminous Concrete Mixtures:
   a. Density: AASHTO T166.
   b. Compaction: ASTM D 2950.

C. Composition and Compaction Acceptance Tests

1. Where plant inspection is maintained, bituminous concrete will be acceptable for use if the specified tests from samples obtained at the production plant indicate conformance to the approved job mix formula.
2. For determination of pavement density, perform in-place density testing by the Nuclear Density Method, ASTM D 2950. The number of tests shall be determined by the MBTA QA lab.
3. The Authority may also require bituminous cores to determine in-place density.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Performance Graded Asphalt Binder: AASHTO M320, grade as indicated, except that the requirements listed under Table 02513-A shall apply.

B. Cutback Asphalts

1. Medium-Curing: AASHTO M82, grade as indicated.

C. Bituminous Emulsions

1. Asphaltic Emulsions: AASHTO M140, grade as indicated. Use grade RS-1 for prime coat or tack coat.
2. Cationic Emulsified Asphalt: AASHTO M208, grade as indicated.
3. Clay-Type Asphalt Emulsion: A mineral colloid type of asphalt emulsion containing no chemical emulsifiers and meeting the following requirements:
   a. Percent water, per AASHTO T59: 40 to 55
   b. Percent residue by evaporation, per AASHTO T59: 45 to 60
   c. Percent ash in residue, per ASTM D1010: 5 to 15
   d. Curing time, per Massachusetts DPW standard test procedures: firm set in 48 hours maximum
   e. Resistance to water, per Massachusetts DPW standard test procedures: no re-emulsification.
4. Protective Seal Coat Emulsion: a homogeneous emulsion consisting of coat tar pitch dispersed in water by means of a mineral colloid, containing no asphaltic materials or chemical

emulsifiers; capable of overcoming any separation or coagulation of its components by moderate stirring; meeting the following requirements:

a. Percent Water, per AASHTO T59: 50 maximum
b. Percent non-volatile matter, per ASTM D1010: 48 minimum
c. Percent ash in non-volatile matter, per ASTM D1010: 20 to 45
d. Percent solubility on non-volatile matter in carbon disulfide: 40 minimum
e. Resistance to water, per ASTM D466: no blistering, loss of adhesion, or re-emulsification
f. Resistance to petroleum solvents, per ASTM D466 with solvents substituted for water: no penetration nor loss of adhesion.

D. Asphalt Anti-Stripping Additive

1. General: An additive to asphalt to assist in the coating of wet aggregate and to increase the resistance of the bituminous coating to stripping in the presence of water; shall be chemically inert to asphalt (heat stable) and when blended with asphalt shall withstand storage at a temperature of 400 degrees F for extended periods without loss of effectiveness.
2. Composition: An organic chemical compound free from inorganic mineral salts or inorganic mineral soaps, containing no ingredient harmful to the bituminous material or to the operator, and not appreciably altering the specified characteristics of the bituminous material; chemically inert to asphalt.
3. Heat Stability: The compound shall retain its effectiveness after heating in asphalt according to the prescribed method for 24 hours at 350 degrees F.
4. Resistance to Stripping. Treated Bitumen shall coat wet aggregate and shall retain at least 90 percent of the coating after 24 hours of static immersion. There shall be no loss of the retained coating after the immersion has been extended to one week.

E. Coarse Aggregate

1. General: Clean, crushed rock consisting of the angular fragments obtained by breaking and crushing shattered natural rock, free from a detrimental quantity of thin or elongated pieces, and free from dirt or other objectionable materials; having a percentage of wear of not more than 30; surface dry and having a moisture content of not more than 0.5 percent after drying. The use of crushed gravel stone will not be permitted.
2. Gradation: Blended from the stone sizes listed in Table 02513-B. Each stone size shall meet its respective gradation as tabulated in Table 02513-B. Sizes other than primary stone sizes may be used providing they are separately introduced on the cold feed belt and can be shown to be an improvement to the mix. Such usage shall require the prior written approval of the Engineer.

F. Fine Aggregate

1. General: Natural or stone sand or a blend thereof; or a blend of natural sand and stone screenings, or a blend of stone, sand and stone screenings;
   a. Natural Sand: Clean, inert, hard durable grains of quartz or other hard durable rock, free of loam, clay, surface coatings or other deleterious substances.
   b. Stone Sand: Process from the stone screenings, of either a primary or secondary crusher to produce a product that when used alone or blended in any combination with natural sand shall meet the specified gradation requirements. Wash plant or other equipment used for processing stone sand shall be as accepted by the Engineer.

G. Mineral Filler: Portland cement, limestone dust, hydrated lime, stone float, or stone dust, 100 percent passing a No. 50 sieve and not less that 65 percent passing a No. 200 sieve. Stone dust shall be

produced from crushed ledge stone and shall be the product of a secondary crusher so processed as to deliver a product of uniform grading.

H. Reclaimed Asphalt Pavement (RAP): Reclaimed Asphalt Pavement (RAP) shall consist of the material obtained from the highways or streets by crushing, milling, or planing existing hot mix asphalt pavements. This material shall be transported to the hot mix asphalt production facility yard and processed through an appropriate crusher so that the resulting material will contain no particles larger than the maximum aggregate size of the hot mix asphalt mixture in which it will be used. The material shall be stockpiled on a free draining base and kept separate from virgin aggregates. The material contained in the RAP stockpiles shall have a reasonably uniform gradation from fine to coarse and shall be protected from accumulation of excessive moisture and shall not be contaminated by foreign materials. The use of RAP will be permitted provided that the end product is in conformance with the approved job-mix formula. The proportion of RAP to virgin aggregate for base course mixtures and intermediate course mixtures shall be limited to a maximum of 40% for drum mix plants and 20% for modified batch plants. The maximum amount of RAP for surface course mixtures shall be 10%.

2.2 CLASS I BITUMINOUS CONCRETE MIXES

A. Provide Class I bituminous concrete mixtures composed of mineral aggregate, mineral filler if required bituminous material, and anti-stripping additive if required, proportioned as specified herein to conform to the composition by weight tabulated in Table 02513-C and in the approved job mix formulae.

B. Use sufficient mineral filler to correct any deficiencies in grading of fine aggregate.

C. Anti-stripping additive, if required, shall be incorporated and thoroughly dispersed in the bituminous material in an amount equal to the percent by weight established by the Authority's Materials Testing Laboratory. This percent will be based on the efficiency of the additive as determined by laboratory tests. No modification of the established additive concentration will be permitted because of the use of hydrophobic aggregate. The Authority reserves the right to establish as minimum the percentage of additive required. Blend additive in the refinery with the asphalt in the presence of the Inspector.

D. The percentages stated herein and in Table 02513-C are stated as proportional percentages of integral total aggregate for the mix.

E. Furnish Intermediate Course, with anti-stripping additive, for use as protective (bottom) course of pavements on bridges, and elsewhere as indicated.

F. Furnish Patching Mix with one percent hydrated lime.

PART 3 - EXECUTION

3.1 PLANT REQUIREMENTS

A. General: The plant used in the production of bituminous concrete shall comply with AASHTO M156, subject to the following additional requirements.

B. Plant Scales

1. Scales for measuring materials into the mixtures shall be springless dial type and shall be of standard make and design. Scale graduations and markings shall be plainly visible and dials shall be so located as to be easily readable from the operator's normal work station by direct sight or through repeating dials. Parallax effects shall be reduced to the practical minimum with clearance between indicator index and scale graduations not exceeding 0.06 inch. Dials shall be equipped with a full complement of adjustable index pointers for marking the required weight of each material to be weighed into the batch.
2. Digital scales will be either electric/mechanical (load cell and lever system) or fully electronic (all load cell). Digital indicators shall be of standard make and design. Scale graduations and capacity shall be plainly visible on the faceplate of the indicator, if panel mounted. If the unit is of desktop or wall-mount variety, a data sticker shall be located on the side of the unit. Indicators must be located as to be easily readable from the operator's normal workstation by sight.
3. Bitumen scales shall be accurate to 0.05 percent, have minimum graduations not greater than 0.025 percent, and shall be readable and sensitive to 0.0125 percent or less. Scales for any weigh box or hopper shall be accurate to 0.5 percent, have minimum graduations not greater than 0.5 percent and shall be readable and sensitive to 0.25 percent or less. The preceding percentages for both bitumen and aggregate scales are based on the maximum total batch weight of the mixtures.

C. Testing of Scales

1. All plant scales, including truck scales, shall be tested at the expense of the Contractor by a competent scale technician as follows:
   a. Annually prior to use in Authority work.
   b. At intervals of not more than 90 calendar days.
   c. At any time ordered by the Engineer.
2. A cradle or platform approved by the Engineer for each scale and at least ten standard fifty-pound test weights shall be provided for testing scales whenever directed by the Engineer. The use of a set of test weights for two or more plants will be permitted only when they can be made readily available with no more than an hour's notice.

D. Automated Batching

1. Automatic proportioning. Batch type mixing plants shall be equipped with approved automatic proportioning devices. Such devices shall include equipment for accurately proportioning batches containing the various components of the mixture by weight in the proper sequence and for controlling the sequence and timing of mixing operations. Interlocks shall be provided which will hold or delay the automatic batch cycling whenever the batched quantity of any component is not within the specified weight tolerance, when any aggregate bin becomes empty or when there is a malfunction in any portion of the control system. The weight setting and time controls shall be so equipped that they may be locked when directed by the Engineer.
2. Automatic Recordation. Recordation equipment shall be provided. Each recorder shall include an automatic printer system. The printer shall be so positioned that the scale dial and the printer can be readily observed at one location by the plant inspector. Use of repeating dials or an additional printer to achieve this condition will be permitted. The printer shall print, in digital form, on a delivery ticket the following data:
   a. Date mixed.
   b. Time of batching.
   c. Tare weight of aggregate weigh box.
   d. Tare weight of bitumen weigh bucket.
   e. Accumulative weights as batched for each bin. (Total of last bin will be aggregate total).

f. Weight of bitumen.

g. Total weight of mix in truck (Pay weight). This printed ticket shall be used in lieu of truck scale weights.

3. Equipment Failure. If at any time the automatic proportioning of recording system becomes inoperative, the plant will be allowed to batch materials manually for a period not in excess of two working days. Manual batching for longer periods will require written permission of the Engineer.

4. Batching Controls

a. The batching controls shall meet the following delivery tolerances with respect to the various components weighed in each batch:

1. Tare Weight of Aggregate Weigh Box: + 0.5 percent of total batch weight.
2. Tare Weight of Bitumen Weigh Bucket: + 0.1 percent of total batch weight.
3. Individual Aggregate Components: + 1.0 percent of total batch weight.
4. Combined Aggregate Components: + 1.5 percent of total batch weight.
5. Mineral Filler: + 0.5 percent of total batch weight.
6. Asphalt: + 0.1 percent of total batch weight.

b. The total weight of the batch shall not vary more than plus or minus 2 percent from the theoretical design weight.

c. If directed by the Engineer, provisions shall be made for locking controls against tampering.

E. Plant Laboratory

1. A building shall be furnished at the site of the producing plant suitable for the housing and use of equipment necessary to carry on the various tests required and for recording and processing test results. This building shall be for the exclusive use of the Engineer or his representatives for testing and recording purposes.

2. The building shall have a minimum floor area of 100 square feet; the least dimension to be 6 feet. Windows and doors shall be adequately screened; satisfactory lighting, heating and water shall be supplied. A table, chairs, desk and work bench shall be provided. Provision shall be made for the safe performance of extraction test determinations by providing an adequate exhaust fan and suitable means of disposing of used solvent and other waste.

3. If the Engineer permits, the plant laboratory may be part of another building in which case it shall be entirely partitioned off from the remainder of such building.

4. Testing equipment shall be furnished as follows and installed in the building for use in testing the materials and mixtures supplied by the Plant for the work:

a. One Approved Rotary Extractor.

b. One Coarse Aggregate Sieve Shaker, power driven with a minimum clear siege area of 324 square inches. The shaker shall be attached to a firm anchorage.

c. One each of the following square opening screens for coarse aggregate shaker: 2 inch, 1-1/2 inch, 1 inch, 3/4 inch, 1/2 inch, 1/8 inch, No. 4 and No. 8.

d. One Fine Aggregate Sieve Shaker, power driven and independent of the coarse aggregate shaker, for eight inch minimum diameter sieves.

e. One each of the following standard eight inch minimum diameter square opening sieves: 3/4 inch, 1/2 inch, 3/8 inch, No. 4, No. 8, No. 16, No. 30, No. 50, No. 100, and No. 200, with pan and cover.

f. One Sample Splitter with a minimum capacity of one cubic foot. It shall be the clam shell type and the chute width shall be adjustable from a minimum of 1/2 inch up to 2 inches.

g. One Solution Balance, 20 kilogram capacity, weighing directly to 1 gram, with two weighing beams and a taring beam; tare capacity to be 2 kilograms; weighing beams to read 1000 grams by 100 gram divisions and 100 grams by 1 gram division. Additional

matching weights (one 1 kg., two 2 kg., one 5 kg., and one 10 kg.) shall be provided to fulfill the capacity of 20 kilograms. The platform to be 11 inches in diameter.

h. One Approved Scale with a minimum capacity of 2000 grams and with a sensitivity of 0.50 grams

i. Two Approved Dial Type Thermometers, range 50 degrees F. to 500 degrees F.

j. One Approved Hot Plate

5. Approval of a plant will be contingent upon approval of the aforementioned requirements for Plant Laboratory, including the building and appurtenances, furnishings, facilities including heat, light, power and water, the testing equipment, and any other incidentals.

F. Sampling facilities. Adequate and convenient sampling facilities shall be provided to allow the Inspector to obtain representative samples from the full width and depth of the discharge area of each aggregate bin. The sampling tray shall be structurally supported during the sampling operation. Access to the sampling facilities shall be provided requiring no more difficulty than that to climb a ladder leading to a secure platform with railings.

G. Inspection. The Engineer or his authorized representative shall have access at any time to all parts of the plant for:

1. Inspections of the conditions and operations of the plant.
2. Confirmation of the adequacy of the equipment in use.
3. Verification of the character and proportions of the mixture.
4. Determination of temperatures being maintained in the preparation of the mixtures.
5. Inspection of incidental related procedures.

3.2 PREPARATION OF MIXTURES

A. Preparation of Asphalt Cement. Place bituminous materials in the mixer at a temperature between 275 and 375 degrees F., as directed.

B. Preparation of Mineral Aggregate. Thoroughly dry and heat aggregates before placing them in the mixer. Control the temperature of the aggregates so that the temperature of the complete mixture shall be within the range specified in paragraph C. below.

C. Preparation of Bituminous Concrete Mixtures. Combine the heated and dried aggregates and mineral filler and convey them into the mixer in the proportionate amounts of each size required to meet the job mix formula. After these materials have been mixed for the specified dry-mixing time, add the asphalt cement and mix for the specified wet-mixing time. Measure asphalt cement by weight or by an approved metering device. The temperature of the mixture when discharged shall be between 275 and 325 degrees F.

3.3 TRANSPORTATION AND DELIVERY OF MIXTURES

A. Vehicles for transportation of mixtures from the plant to the jobsite shall be clean of all foreign materials, tight, and evenly and lightly coated with a suitable thin oil or approved soap solution. No excess of lubricant shall be allowed to accumulate in low spots in the body. When necessary, vehicles shall be insulated so that the mixture is delivered for placement at the proper temperature.

B. Arrange dispatching of trucks from the plant so that all material which is delivered to the jobsite during any day shall be placed and shall have received final compaction before nightfall of the same day, unless satisfactory artificial light is provided.

C. Do not transport mixtures such a distance that segregation of the ingredients takes place or that any crust is formed on the top, bottom, or sides of the mixture which will not crumble or flatten out when the mixture is dumped or which might otherwise be deleterious to the mixture in place on the work.

D. During transportation of the mixture from the plant to the spreader at the jobsite, keep the mixture fully covered at all times with canvas or other suitable material of sufficient size and thickness to furnish complete protection.

E. Deliver the mixture to the jobsite at a temperature governed by the air temperature in the shade and away from artificial heat, as follows with a tolerance of plus or minus 20 degrees F.:

1. Normal Layered Construction:

Air Temperature	Delivered Mix Temperature
35 degrees F.	300 degrees F.
40 degrees F.	290 degrees F.
65 degrees F.	280 degrees F.
90 degrees F. and Over	275 degrees F.

2. Deep Lift Paving (3 inches and over), Base and Binder Courses only:

Air Temperature	Delivered Mix Temperature
35 degrees F.	280 degrees F.
40 degrees F.	270 degrees F.
65 degrees F. and over	260 degrees F.

3.4 PRIME COAT (OR TACK COAT)

A. Where an existing hardened surface is used as a base for new pavement, or elsewhere where the surface to receive bituminous pavement is, in the Engineer's judgment, unsatisfactory to receive the pavement, give the surface a prime coat of bituminous material of the kind and grade indicated or directed. Where unsatisfactory conditions, requiring application of prime coat, are due to the fault of the Contractor, provide the prime coat at no additional expense to the Authority.

B. Clean the existing surface of all foreign matter and loose material before applying prime coat. Apply the prime coat by mechanical means at the rate indicated or directed.

3.5 SPREADING AND FINISHING

A. General

1. Place bituminous concrete in courses as indicated.
2. When an existing surface or new base, upon which the bottom course is to be laid, contains unsatisfactory irregularities, in the Engineer's judgment, eliminate such irregularities by placing and compaction of mixture, so as to furnish a surface with true contour and grade before placing any specified bottom course.
3. Paint thoroughly the contact surfaces of bridge curbings, manholes, catch basins, and other appurtenant structures in pavement, with a thin coating of bitumen immediately prior to placing any mixture against them.
4. Give special attention to proper testing of the surface of each course with a straightedge. Finished surfaces shall be even and uniform throughout.
5. Remove and replace with new mixture any mixture which becomes loose or broken, mixed with dirt, or defective in any way. Finish and compact the repaired area to conform to the surrounding area. Remove and replace areas of one square foot or more showing an excess of bitumen.
6. No mixture shall be placed unless the breakdown and intermediate rolling can be completed by the time the material has cooled at 175 degrees F., and provided that the density of the pavement attains at least 95 percent of the laboratory compacted density.

B. Spreading and Finishing Equipment

1. The equipment for spreading and finishing shall be mechanical, self powered pavers, capable of spreading and finishing the mixture to line, grade, width, and crown by means of fully automated controls for both longitudinal and transverse slope.
2. The pavers shall be equipped with hoppers and distributing screws of the reversing type to place the mixture evenly in front of adjustable screeds. They shall be equipped with a quick and efficient steering device and shall have reverse as well as forward traveling speeds.
3. The pavers shall employ mechanical devices such as equalizing runners, straight edge runners, evener arms or other compensating devices to adjust the grade and confine the edges of the mixture to true lines. They shall be capable of spreading the mixture without segregation in layers to the depths and widths required. They shall be equipped with blending or joint leveling devices for smoothing and adjusting all longitudinal joints between adjacent strips or courses of the same thickness.
4. The screed shall be adjustable for profile and shall have an indicating level attached.
5. An approved device will be required for heating the screed to the temperature required for the laying of the mixtures without pulling or marring.
6. The term "screed" includes any "strike-off" device operated by cutting, crowding, or other practicable action, which is effective on the mixtures at permissible workable temperatures without tearing, shoving, or gouging and which produces a finished surface of the evenness and texture required.
7. The pavers employed on projects requiring in excess of 15,000 tons shall operate by the use of a sensing grid for operation to a stringline and matching shoe for joints.
8. The paver shall be provided with a "ski" which may be employed for paving on the previously laid bituminous concrete base, or binder as directed or permitted by the Engineer.
9. The paver employed on deep lift construction shall be capable of satisfactorily feeding the mix without intermittent stopping during the discharge of the mix from the trucks into the paving machine.
10. 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.
11. Complete all compaction rolling before the bituminous concrete temperature drops below 185 degrees Fahrenheit.

C. Machine Spreading

1. Deposit mixtures in the approved mechanical spreader, spread immediately, and strike off in a uniform layer to the full width required and to such depth that each course, when compacted, shall have the required thickness and shall conform to the indicated grade and cross section contour.
2. Deposit mixture in the center of the hoppers, exercising care to avoid overloading and spilling. Operate the pavers, while the mixture is being spread, at a speed which will produce a uniform surface texture.
3. Immediately after each course is screeded and before roller compaction is started, check the surface, adjust any irregularities, remove accumulation from the screed by rake or lute, and remove and replace any unsatisfactory spots in the course. Correct irregularities in line and grade along outside edges by addition or removal of material before the edge is rolled. Indiscriminate casting of mix on the new screeded surface, where irregularities are not evident, will not be permitted.
4. All edges shall be true and uniform.

D. Hand Spreading

1. 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.
2. When hand spreading is permitted, place the mixture by dumping on approved steel dump sheets outside the area upon which it is to be spread; or by other approved methods. Immediately thereafter, distribute the mixture into place by means of hot shovels, and spread it with hot rakes or lutes in a loose layer of uniform density and correct depth. Tines of the rakes shall be not less than 1/2 inch longer than the loose depth of mixture and spaces between tines shall be not less than 1 inch.
3. Do not dump loads faster than they can be properly handled by the shovelers, and do not distribute the dumped load faster than it can be properly handled by the rakers. Rake carefully and skillfully to avoid segregation and so that, after the first passage of the roller over the raked mixture, no back patching will be necessary.

3.6 COMPACTION

A. Compaction Equipment

1. After the paving mixture has been properly spread, initial compaction shall be obtained by the use of power rollers of approved design and weight per inch width of roller. The rollers shall be steel-wheeled supplemented with pneumatic-tired rollers where required, or where permitted, vibratory rollers.
2. Steel wheel rollers for initial and intermediate rolling shall have a weight of not less than 240 pounds per inch width of tread; for top course, minimum weight shall be 285 pounds per inch width of tread.
3. Pneumatic-tired rollers, when conditions warrant, shall be provided with devices capable of varying tire pressures. When the mixture being spread by each paver requires more than the minimum number of steel wheel rollers, at least one of the additional rollers for each paver shall be a pneumatic-tired roller, except where the use of a vibratory roller is permitted. When using a pneumatic-tired roller, care shall be taken that initial rolling by the steel wheel roller be restricted to one pass where upon the pneumatic-tired roller shall immediately follow the initial steel wheel rolling.

4. Vibratory steel drum rollers shall not be used on top course mix or structures. The machine shall have a device registering the number of vibrations per minute and a tachometer shall be provided to the Engineer in order to check the operation of the roller.
5. The V.P.M. on base and binder course material shall be a minimum of 1400 V.P.M. and a maximum of 1500 V.P.M., or in accordance with the recommendations of the manufacturer, when approved by the Engineer.
6. The vibratory roller shall be operated with the vibrating drum in the direction of the paver and the vibrating action of the roller shall be completely shut off during change of direction and care exercised to start this action only when the roller is in motion. In order to prevent creeping and aggregate crushing during rolling of layered pavement, care shall be taken not to exceed one pass in the direction of the paver with vibrator in action and one return in a static condition and for deep lift pavements these passes shall not exceed two operations in each direction, except that the number of vibratory passes in either direction may be varied in order to obtain the required density.
7. A smoothing roller of either the pneumatic-tired or steel wheeled type shall be used immediately behind the last pass of the vibrating roller. The use of a vibratory roller may be suspended by the Engineer if, in his opinion, unsatisfactory results are being obtained and no further mix shall be spread until a sufficient number of approved rollers are on the project to satisfy the compaction requirements.
8. A plate shall be attached to each roller which shall show the ballasted and unballasted weight per inch width of tread.
9. The number of rollers and passes required shall be governed by the compaction results; however, at least one steel roller shall be provided for each paver employed on the paving operation. This is independent of the requirements of the pneumatic-tired roller.

B. Compaction Procedures

1. Roll the mixture longitudinally, diagonally, and transversely as may be necessary to produce the required contour for surface. Start longitudinal rolling at the side and proceed toward the center of the pavement, except on superelevated curves start at the low side and progress to the high side, overlapping on successive trips by at least 12 inches.
2. Continue the rolling so that all roller marks, ridges, porous spots, and impressions are eliminated and the surface has the required contour and grade. Maintain the motion of the rollers at all times slow enough to avoid any displacement of the hot mixture. Correct any displacement or marring of the surface resulting from reversing the direction of the roller or from any other cause.
3. To prevent adhesion with the mixture, keep the wheels of steel rollers lightly moistened with water. Excess water or oil for this purpose will not be permitted.
4. To prevent "rolloff" of the pavement edges and longitudinal joints on deep lift paving, leave the outer eight inches of the deep lift mixture unrolled until the temperature of the mix ranges between 150 and 180 degrees F., whereupon compact it with a steel roller.
5. Along curbs, structures, and all places not accessible with a roller, compact the surface thoroughly with mechanical tamping devices, smooth and true to established line, grade, and contour.
6. Density of completed pavement shall not be less than 95 percent of the density obtained from laboratory compaction of a mixture composed of the same materials in like proportions.

3.7 JOINTS

A. Place mixture as nearly continuously as possible. Pass the roller over the unprotected end of newly placed mixture only when the placing of the course is to be discontinued for such length of time as

will permit the mixture to attain initial stability. In all such cases, including the formation of joints as herein specified, provide for proper bond with the new surface for the full specified depths of the courses.

B. Maximum length of longitudinal joint shall be such that the temperature of the mixture at the joint shall not be less than 150 degrees F. when the abutting mixture is placed.

C. Make longitudinal and transverse joints in a careful manner, well bonded and sealed, true to line and grade. Where directed, cut back longitudinal and transverse joints to expose the full depth of the course and, when laying of the course is resumed, paint the exposed edge of the joint with a thin coat of bitumen. Carefully rake the new mixture against the joint, then thoroughly tamp and roll.

D. In making joints along any adjoining edge such as curb, gutter, or an adjoining pavement, and after the mixture is spread by the paver, place by hand just enough of the hot material to fill any space left open. Set up these joints with the back of a rake at the proper height and level to receive the proper compaction.

E. Stagger longitudinal joints in successive courses so that there is a minimum of one foot overlap between longitudinal joints in adjacent courses.

F. Overlap the rolling of successive widths of courses so as to leave smooth, uniform joints and cross sections.

3.8 PAVEMENT ON BRIDGES

A. Place Intermediate Course for protective course within 24 hours after the membrane waterproofing over the area has been placed. Do not permit vehicular traffic over any bare membrane waterproofing.

B. Place Top Course only after curbing and edging are in place in the work.

3.9 FIELD QUALITY CONTROL

A. Test the plane of the finished surfaces of base, binder, and surface courses with a 16-foot straightedge, except use a 10-foot straightedge on vertical courses and on the top course of resurfaced streets which contain manhole covers, valve boxes, and the like.

B. Carefully apply the straightedge immediately after the first compaction by rolling, and from then on as may be necessary until and after the final compaction of the material in place. Hold the straightedge in successive positions parallel to the road centerline and in contact with the road surface; check the entire area from one side of the pavement to the other.

C. Correct irregularities which vary 3/8 inch from a true finished surface in base and binder courses, and 1/4 inch in top courses.

D. Irregularities which may develop before the completion of rolling and while the material is still workable, may be remedied by loosening the surface mixture and removing or adding material as necessary. Should any unsatisfactory irregularities or defects remain after final compaction, correct the defective work by removing and replacing with new material to form a true and even surface.

3.10 OPENING TO TRAFFIC

A. No vehicular traffic or loads shall be permitted on the newly completed pavement until adequate stability has been attained, and the material has cooled sufficiently to prevent distortion or loss of fines, and the pavement has achieved a maximum temperature of 140 degrees F.

B. If the climatic or other conditions warrant it, the period of time before opening to traffic may be extended at the discretion of the Engineer.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Bituminous concrete will be measured by the ton complete in place, determined by weight slips countersigned by the Engineer at time of delivery. The Schedule of Bid Prices may provide for separate measurement of the different mixtures.

B. Bitumen for prime coat will not be measured separately, but will be included in the Contract Unit Price bid for Item 0261.151 – Bituminous Concrete Pavement.

C. All grinding, hot patching and sealing, saw cutting, and other preparation work for existing pavement will not be measured separately, but will be included in the Contract Unit Price bid for Item 0261.151 – Bituminous Concrete Pavement.

D. Timber walls and other edging along walkways will not be measured separately, but will be included in the Contract Unit Price bid for Item 0261.151 – Bituminous Concrete Pavement.

4.2 PAYMENT

A. Bituminous concrete will be paid for at the Contract unit prices for the quantities determined as specified above.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0261.151	BITUMINOUS CONCRETE PAVEMENT	TN

TABLE 02513 – A

SPECIFICATION REQUIREMENTS FOR PERFORMANCE GRADED ASPHALT BINDERS

TESTS AT PG TEMPERATURE deg. C.	PG 64-22	PG 64-28	PG 52-34
Viscosity, Brookfield 135 degrees C Pa-sec.	3 Max.	3 Max	3 Max
Dynamic Shear, 10 Rad./sec. Kpa	1.00 Min.	1.00 Min.	1.00 Min.
RTFO, % Change	1.0 Max.	1.0 Max.	1.0 Max.
RTFO, Residue Dynamic Shear, KPa	2.20 Min.	2.20 Min.	2.20 Min.
PAV Residue Dynamic Shear, KPa	5,000 Max.	5,000 Max.	5,000 Max.
Creep Stiffness (s), MPa	300 Max.	300 Max.	300 Max.
M Value	0.300 Min.	0.300 Min.	0.300 Min.

TABLE 02513-B

GRADATION REQUIREMENTS FOR COARSE AGGREGATE (PERCENT BY WEIGHT)

Nominal Size of Stone Sieve Size	2 in.	1-1 /2 in.	1-1 /4 in.	3 /4 in.	1 /2 in.	3 /8 in.
2-1/2"		100				
2"	90-100	100				
1-1/2"		95-100	100			
1-1/4"	25-50		85-100			
1"		35-70		100		
3/4"	0-15	0-25	10-40	90-100		
5/8"					100	
1/2"	0-5		0-8	10-50	85-100	100
3/8"				0-20	15-45	85-100
No. 4				0-5	0-15	20-50
No. 8					0-5	0-15
No.16						0-5

TABLE 02513-C

MASTER RANGES FOR JOB MIX FORMULAE (PERCENT BY WEIGHT)

Standard Sieves	Base Course	Binder Course	Interme-diate Course	Top Course	Dense Mix	Surface Treatment	Patching Mix
2"	100						
1-1/2"	90-100						
1"	65-90	100	100				
3/4"	55-80	80-100	76-98				
1/2"	40-65	55-80	66-86	100	100		100
3/8"			57-77	80-100	80-100	100	90-100
No. 4	20-45	28-50	40-60	50-76	55-80	80-100	50-65
8	15-33	20-38	26-46	37-54	48-63	64-85	24-36
No. 16			17-37	26-40	36-49	46-68	14-28
30	8-17	8-22	11-27	17-31	24-38	26-50	8-25
No. 50	4-12	5-15	7-19	10-23	14-27	13-31	5-21
100			6-16	5-16	6-18	7-17	3-15
200	0-4	0-5	3-6	2-7	4-8	3-8	2-8
Bitumen	4-5	4.5-5.5	4.5-6.0	5.5-7.0	7-8	7-8	4-6

TABLE 02513-D

ACTION LIMITS FOR AGGREGATE GRADATIONS AND BINDER CONTENT

SIEVE DESIGNATION/BINDER CONTENT	ACTION LIMIT
Passing No.4 Sieve and Larger Sieve Sizes	JMF Target +/- 6%
Passing No. 8 Sieves	JMF Target +/- 5%
Passing No. 16 to No. 50 Sieves (Inclusive)	JMF Target +/- 3%
Passing No. 100 Sieve	JMF Target + /- 2%
Passing No. 200 Sieve	JMF Target +/- 1%
Binder	JMF Target +/-0.3%

Deviations from the final approved mix design for bitumen content and gradation of aggregates shall be within the action limits for individual measurements as specified in Table 02513-D. The limits still will apply if they fall outside the master grading band in Table 02513-C.

END OF SECTION

SECTION 02524

CURBS, GUTTERS AND WALKS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies the construction of Portland cement concrete curbs, gutters, and walks.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 02300 - EARTHWORK
2. Section 03300 - CAST-IN-PLACE CONCRETE; for concrete, reinforcement, and incidentals pertaining thereto.

1.2 QUALITY ASSURANCE

A. Tolerances. Construct concrete surfaces within 1/4 inch of the indicated elevation, and deviating not more that 1/8 inch from a ten-foot straightedge placed anywhere on the surface.

B. Provide strict compliance with requirements for air entrainment and curing.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete: Section 03300 - CAST-IN-PLACE CONCRETE, 4,000 psi.

B. Preformed Joint Filler: AASHTO M153.

C. Hot-Poured Joint Sealer: AASHTO M173.

D. Gravel Borrow: Section 02300 - EARTHWORK.

PART 3 - EXECUTION

3.1 PREPARATION

A. Excavate for and prepare the subgrade as specified in Section 02300 - EARTHWORK, true to the indicated grade and cross section.

B. Place and compact a foundation of gravel borrow to the indicated thickness upon the prepared subgrade.

C. Test completed gravel foundation with a template supported on the side forms, prior to concreting.

3.2 JOINTS

A. Expansion Joints. Construct expansion joints at intervals as indicated but not exceeding 30 feet, and wherever new concrete abuts existing construction.

B. Contraction (Control) Joints. Using a grooving tool having a depth equal to at least 1/4 the sidewalk thickness, groove sidewalks in uniform intervals not exceeding six feet. Sidewalk Control Joints can also be saw cut after concrete has set overnight.

3.3 FINISHES

A. Pedestrian and Wheelchair Ramps: Non-slip finish.

B. All Other: Broom finish.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Concrete sidewalks will be measured by the square yard, complete in place including expansion joints and all labor materials, equipment and incidentals necessary to satisfactorily complete the work.

B. Concrete Pedestrian ramps and wheelchair ramps within sidewalk areas will be measured by the square yard of concrete sidewalks, complete in place.

C. Polypropylene Fibre and Steel Reinforcement for concrete walks will not be measured separately but will be considered incidental to the items of work to which they pertain.

4.2 PAYMENT

A. Walks will be paid at the Contract unit prices for quantities determined as specified above.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0263.150	CONCRETE SIDEWALKS	SY

END OF SECTION

SECTION 02525

GRANITE CURBS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies furnishing and installing granite curb, granite curb transitions and sloped granite edging, as indicated on the Contract Plans and in accordance with these Specifications or as a replacement for existing curb which is damaged or removed during the course of the work.

B. The work under this section also includes removing and resetting, and removing and discarding existing curbing, as indicated on the contract plans and/or as directed by the Engineer.

1.2 QUALITY CONTROL

A. Tolerances. Place curbing within ¼ inch of the indicated elevations or dimensions, deviating not more than ¼ inch from a ten-foot straight-edge placed anywhere on the surface.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All curbing work shall be in accordance with the Commonwealth of Massachusetts, Massachusetts Highway Department "Standard Specifications for Highways and Bridges," Section 500. Curb and Edging, and Materials Section M9.04.1, Granite Curb, Type VA 4.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Excavate for and prepare the subgrade as specified in Section 02200, true to the indicated grade and cross section.

B. Place and compact a foundation to the indicated material and thickness upon the prepared subgrade.

C. Test the complete foundation with a template supported on the side forms, prior to placing the curbing.

D. Install High-Early strength concrete setting bed as indicated on the contract plans and/or as directed by the Engineer.

E. All transition curbing shall be cut at the end adjoining adjacent curbing so that ends are vertically flush.

F. The corner curbs shall be cut so they are constructed with flush joints.

G. Transition curbing at ramps, as shown on the Contract Plans.

H. Curbing which is to be removed and reset, will be installed as indicated above.

I. Curbing which is removed and stacked and not wanted by the Authority shall be satisfactorily disposed of by the Contractor.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Granite Curb will be measured by the linear foot of each type, complete in place including all accessories and incidentals.

B. Curbing to be removed and reset, will be measured by the linear foot, complete in place including, removal, placement and all accessories and incidentals.

C. Curbing to be removed and stacked will be measured by the linear foot, complete in place, including removal, transport, and all other incidentals.

4.2 PAYMENT

A. Payment for Granite Curbs will be made at the Contract unit price for the quantities determined as specified above. No payment will be made for the replacement and removal from the site of curb which is damaged in the course of the work or for the resetting of curb which is removed, displaced from existing line or grade, or otherwise disturbed during the course of the work.

4.3 PAYMENT ITEMS

Item No.	Description	Unit
0262.214	GRANITE CURB TYPE VA 4 STRAIGHT	LF
0262.215	GRANITE CURB VA 4 CURVED	LF
0262.251	GRANITE TRANSITION CURB	LF
0262.701	CURBING – REMOVE AND RESET	LF
0262.702	CURBING – REMOVE AND STACK	LF
0262.720	CURBING – REMOVE AND DISCARD	LF

END OF SECTION

SECTION 02577

PAVEMENT MARKING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies the furnishing and application of reflectorized pavement markings.

B. All work shall be in accordance with the Commonwealth of Massachusetts, Highway Department (MHD) Standard Specification for Highways and Bridges.

1.2 SUBMITTALS

A. Submit a schedule of pavement marking operations to the Engineer, for approval, not less than seven days prior to the proposed date of application of any pavement marking.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Thermoplastic Striping: Comply with MHD requirements. Pavement striping material shall be applied to the pavement in a molten state by mechanical means with a surface application of glass spheres.

1. White Color: Composition by weight:

Binder:	22 percent minimum.
Glass Beads:	30-40 percent.
Titanium Dioxide:	10 percent minimum.
Calcium Carbonate and Filler:	38 percent maximum.

2. Yellow Color: Composition by weight:

Binder:	22 percent minimum.
Glass Beads:	30-40 percent.
Titanium Dioxide:	10 percent minimum.
Yellow Pigment, Calcium Carbonate and Filler:	To be determined by manufacturer.

3. Glass Beads: Beads shall be transparent, clean, colorless glass, smooth and properly shaped, and contain no pits or bubbles, and meeting the following gradation:

Sieve	Percent Passing
No. 20	100
No. 30	75 - 95
No. 50	15 - 35
No. 80	0 - 5

a. When tested by the liquid immersion method, the beads shall have a minimum refraction of 1.50.

B. Acrylic Striping: Comply with MHD requirements. Pavement striping material shall be an acrylic type, low VOC, water based paint.

1. White Color: Composition by weight:
   Pigment: 58 percent minimum.
   Total Solids: 76 percent minimum.
   Titanium Dioxide: 1 pound/gallon minimum.
2. Yellow Color: Composition by weight:
   Pigment: 56 percent minimum.
   Total Solids: 75 percent minimum.
   Titanium Dioxide: 0.3 pounds/gallon minimum.

PART 3 - EXECUTION

3.1 EQUIPMENT

A. Use standard commercial-quality equipment of the type normally required for application of pavement markings. Operate the equipment in accordance with the manufacturers' instructions. Truck-mounted equipment is approved for the application of pavement marking except where in the Engineer's judgment travel will be unreasonably delayed or the quality of the work performed by the equipment is unsatisfactory.

3.2 LAYOUT OF WORK

A. The Engineer will provide at a convenient location on the roadway a line of reference for use by the Contractor in establishing the location of markings. This line of reference will be at a maximum of 50-foot intervals by means deemed satisfactory by the Engineer. Follow this line of reference without deviation. Reapply any line deviating from the establishing control or of incorrect width, as directed by the Engineer.

3.3 APPLICATION OF MARKINGS

A. Apply pavement markings as follows:

MATERIAL	MATERIAL APPLICATION TEMPERATURE DEGREES F	LINE THICKNESS MILS	REFLECTORIZED BEAD APPLICATION
M7.01.08	180-195	15	6 LBS/GAL
M7.01.09	180-195	15	6 LBS/GAL
M7.01.10	40-120	15	6 LBS/GAL
M7.01.11	40-120	15	6 LBS/GAL

MATERIAL	MATERIAL APPLICATION TEMPERATURE DEGREES F	LINE THICKNESS MILS	REFLECTORIZED BEAD APPLICATION
M7.01.03	400-425	6-188	1 LB/20 SF DROP ON
M7.01.04	400-425	5-188	1 LB/20 SF DROP ON

B. Use no thinners for the above-listed pavement marking applications except in accordance with the manufacturer's specifications and at the direction of the Engineer.

C. Heat no paint or pavement marking material above the temperature marked on the container.

D. Apply markings only in seasonable weather and in accordance with good painting practices. The surface shall be dry and free of sand, grease, oil or other foreign substances prior to the application. Prepare the surface to accept the application as part of the work of this section, with no additional compensation. The Engineer will make the final determination for all of the foregoing.

E. Bituminous concrete pavements shall have been in place for 48 hours prior to the application of pavement markings. When it is necessary to expedite the flow of traffic, the Engineer may reduce the waiting period as is deemed necessary.

F. The ambient (air) temperature for thermoplastic application is to be a minimum of 45 Degrees F and rising at the time of marking operations. If work has started and air temperatures fall below 45 Degrees F and continuous cooling is indicated, work shall be stopped. In cool weather conditions, temporary drops down to 40 Degrees F will be tolerated providing temperatures also vary upwards. Sustained striping (greater than one hour) at 40 Degrees F shall not be allowed. Starting work at air temperatures lower than 45 Degrees F shall not be allowed. Contractor shall remove and replace thermoplastic applications below 40 Degrees F at no expense to the Authority.

G. If for any reason material is spilled or tracked on the highway, or any markings applied by the Contractor, in the Engineer's judgment, are of incorrect width or pattern or fail to conform to the established line of reference, remove such material by a method that is not injurious to the roadway surface and is acceptable to the Engineer, clean the roadway surface, prepare the surface for a reapplication of markings, and reapply the markings as directed without additional compensation for any of the foregoing corrective operations.

3.4 PROTECTION OF MARKINGS

A. Protect markings until sufficiently dry to bear traffic on highways that are open to traffic. Protect markings by traffic cones not less than 18 inches in height except in the case of markings which cure to a no-track condition in 180 seconds or less. In the latter case, protection may be provided by a convoy of vehicles with suitable warning devices to warn overtaking or on-coming traffic that the pavement marking operation is in progress.

B. Broken Lines. On tangents and on curves of 1000 foot radius or greater place at least one cone on every other bar. On curves of less than 1000 foot radius place one cone on every bar unless otherwise directed by the Engineer.

C. Solid Lines. On tangents and on curves of 1000 foot radius or greater space cones not over 50 feet apart and on curves of less than 1000 foot radius space cones not over 50 feet unless otherwise directed by the Engineer. On edge lines adjacent to the median, wider spacing may be used as directed by the Engineer. In order to control the proper positioning of the cones during the drying period, assign sufficient personnel as determined by the Engineer. Such control is dependent on traffic density, cone widths, and the like.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Separate measurement and payment will not be made for the work of this section complete in place, but all costs therefore shall be included in the Contract Lump Sum Price for the work as indicated herein.

4.2 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
1040.900	PAVEMENT MARKINGS	LS

END OF SECTION

SECTION 02650

EXISTING SITE UTILITIES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies the maintenance, support, protection, relocation, reconstruction and adjustment-to-grade, restoration, and abandonment of existing utilities affected by the construction work.

B. For the purpose of this Section, utility means any public or private service, such as electric light and power systems; gas distribution systems; telephone, telegraph, cable television and other communication services; water distribution; storm drain and sanitary sewer services; police and fire communication systems; street lighting and traffic signs and signals; parking meters; and steam distribution systems.

1.2 GENERAL

A. The location of existing underground pipes, cables, conduits, and structures as shown on the Contract Drawings have been collected from the best available sources and the Authority together with its agents does not imply or guarantee the data and information in connection with the underground pipes, cables, conduits, structures and other parts as to their completeness nor their locations indicated. The Contractor shall contact utility owners and request marking location of all their lines in the work areas. The Contractor shall assume there are existing water, gas, electric and other utility connections to every building and structure, whether they appear on the Drawings or not. Any expense and/or damage to these shall be the responsibility of the Contractor.

B. Foundations and lines for services, police and fire alarm boxes, street and pedestrian lights, and traffic signals may not be shown on the Drawings. The appropriate utility companies and/or agencies shall be contacted and consulted for locations of the above.

C. All utility companies, public and private, shall be notified, including those in control of utilities not shown on the Drawings (see Chapter 370, Acts of 1963, Massachusetts) prior to designing, excavating, blasting, installing, backfilling, grading, or restoring pavement. The Contractor shall premark the area of excavation or work and notify the Dig Safe Center (1-888-DIG-SAFE) at least three business days prior to any excavation or work. In addition, notification shall be given to all affected private and/or public utilities to permit street marking of their lines.

D. Some unknown utilities may exist in the areas to be excavated. The Contractor shall take the necessary precautions when excavated in areas of potential utility conflict. Precautions may include, but are not limited to soil vacuum excavation, hand digging, or other non-destructive means. The Contractor shall further be prepared to pre-excavate or pre-trench to locate potential utility conflicts prior to performing such activities as, but not limited to jacking, tunneling, installing temporary excavation support, etc.

E. Interruptions of utilities shall not be permitted without written consent of the utility owner. The Contractor shall coordinate with all utilities and provide all temporary utilities and connections to avoid interruptions.

1.3 SUBMITTALS

A. Submit working drawings and, if applicable, shop drawings showing the details, procedures, and scheduling for performance of the existing utility work. Show actual location of existing utility facilities; interferences which these facilities present to the new work; location of settlement markers; method proposed to proceed with the construction; details of proposed support systems; and, if applicable, method of testing and procedure for restoration.

B. Submit written evidence of affected utility owners' approval of the details, procedure, and scheduling.

C. Provide written notice two weeks in advance of the intended date to commence operations, to affected utility owners and parties having surface, subsurface or overhead structures in the construction area. Furnish the Engineer copies of all notices.

D. If a settlement or movement monitoring system is required, submit copies of readings to the Engineer and affected utility owner within 24 hours of the reading.

E. Submit to the Engineer, certifications from the respective suppliers that the products to be incorporated in the work are in conformance with applicable requirements.

1.4 NOTIFICATION

A. Notify the appropriate utility agencies and the Engineer at least 48 hours prior to starting any work involving or adjacent to utility service facilities.

B. Where an existing utility facility is encountered that is not indicated or that is determined to be a different utility facility than that indicated, promptly notify the Authority. The Contractor is responsible for determining the owner of the facility and the disposition of the facility.

PART 2 - PRODUCTS

2.1 GENERAL

A. Products and materials shall be as specified in the Construction Specifications.

2.2 SALVAGE MATERIAL

A. Reuse materials designated to be salvaged, provided they are inspected and approved by the respective utility owner and the Engineer. Salvaged material not designated for reuse or returned to the owner shall become the property of the Contractor.

B. Maintain and have available for inspection by the Engineer a detailed record, including signed vouchers and receipts, of new and salvaged materials received from, used, or returned to the various utility owners.

PART 3 - EXECUTION

3.1 GENERAL

A. Conform to the specifications and standard practices of the affected utility owners. Coordinate with utility owners, which work shall be done by the Contractor and which work shall be done by utility owner at Contractor's expense. Ensure continuity of all existing utility services to all users except when the utility owner determines that temporary interruption is required.

B. Unless otherwise indicated or authorized in writing by the Engineer, maintain all utility facilities complete in place.

C. Abandoned Facilities

1. Demolish and remove abandoned utility facilities in conflict with work.
2. Do not undertake demolition or removal of the service until written approval for such work has been obtained from the utility owner.
3. When abandoned facilities are indicated to be left in place, plug, or cap or bulkhead the ends of conduits and pipes, as indicated. Pipe or conduit greater than 15-in in diameter shall be completely filled with Controlled Density Fill. Remove abandoned utility manholes, junction boxes, and similar structures to a minimum depth of two feet below finish grade and fill the remaining void with sand or select fill, as specified in Section 02300 - EARTHWORK, after the plugging, or capping, or bulkheading of conduits and pipes has been completed. Puncture or break the bottom slabs of manholes and similar structures to provide drainage. Backfill and compact excavations resulting from removal of utility facilities, as required.
4. Bulkheads for pipes greater than 15-in in diameter shall be constructed of solid concrete masonry bricks or solid concrete masonry blocks with full mortar joints. The bulkhead shall be watertight. Recess the bulkhead 1/2-in and seal with non-shrink grout.

D. Provide, install, and maintain all temporary facilities required to provide interim utility service when a utility facility is to be relocated and when a utility facility to be replaced is abandoned prior to replacement.

E. Where an existing utility facility is encountered which is not indicated, or which is determined to be a different utility service than that indicated, promptly notify the Engineer who will assist in determining the owner of the facility and the disposition of the facility.

F. If, upon exposure, the condition or location of a facility to be supported complete-in-place is found by the Engineer to be unsafe for support or for maintenance of service, replace or reconstruct the facility as required, with prior approval of the Engineer and the utility owner.

3.2 SETTLEMENT OR MOVEMENT

A. Provide suitable settlement or movement monitoring systems where indicated or required by the affected utility owner.

B. In case of settlement or other movement which might cause damage, take immediate remedial measures to correct the conditions and damages caused by the settlement.

3.3 RECONSTRUCTION AND ADJUSTMENT-TO-GRADE

A. Relay, reset, or otherwise reconstruct miscellaneous structures and facilities as indicated.

B. Adjust-to-grade manholes and inlets as indicated, by raising or lowering the upper portion thereof.

C. Backfill under utilities supported or exposed using controlled density fill to allow for the proper support and compaction under the utility. Contractor shall coordinate with the utility owner to determine the acceptability of the use of controlled density fill and shall work with the Owner to develop alternate means to ensure the proper backfill and compaction under the utility.

3.4 AS-BUILT UTILITY LOCATION AND CONDITION SURVEY

A. For each new or relocated utility installed, including those installed or relocated by others in the Project Area, perform an as-built location survey by coordinates prior to backfilling the excavation.

B. The survey data shall be obtained by Global Positioning Survey (GPS) and certified by a Professional Land Surveyor registered in Massachusetts.

C. A complete digital base plan shall be provided in AutoCAD DWG format Release 2000i or later on a Compact Disk (CD), properly referenced to the coordinate system established in the contract. The following standards shall be applicable:

1. Text: Text shall be drawn using a STYLE of "L100-XX" (where XX refers to the plotted scale) and a font file of "SIMPLEX" as defined in the AutoCAD survey template provided by the Engineer. The style shall be defined as a "fixed height" style, and have a height of 0.10 times the drawing plotted scale. (i.e. 4.0 for 40 scale plan, 2.0 for 20 scale etc.).
2. Precision and Accuracy:
   a. Horizontal Survey:
      1. Precision: Horizontal control and surveyed points shall maintain a minimum precision of 1:10,000.
      2. Accuracy: No more than 10% of the survey points shall be in error by more than 1/100 inch or 0.25 mm when viewed at the requested scale.
   b. Vertical Survey:
      1. Precision: Vertical Control shall have a maximum error of closure no greater than .075 feet or .02 meters.
      2. Accuracy: No more than 10% of elevations when interpolated from a Surface shall be in error of more than 1/2 a contour interval.
3. Surface Data: The data format shall conform to Autodesk Land Development Desktop Project files. If the Contractor uses a different software product to create a surface, then the surface must be represented as a TIN (Triangulated Irregular Network) of 3D lines on a separate, distinct layer within the AutoCAD drawing file. 3D faces or 2 dimensional lines are NOT acceptable.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. An allowance sum of fifty thousand dollars ($50,000) shall be included in the schedule of bid prices to reimburse the Contractor for work and materials performed and supplied by others to relocate or otherwise modify existing site utilities.

B. Catch basins and manholes to be adjusted to grade, changed in type or reconstructed, will be measured per each unit under the Item 0250.118 – Catch Basin or Manhole Adjusted, complete in place including all accessories and incidentals.

4.2 PAYMENT

A. Payment for the work specified in this Section will be made at the Contract unit prices as indicated above.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0211.445	UTILITY RELOCATION	AL
0250.118	CATCH BASIN OR MANHOLE ADJUSTED	EA

END OF SECTION

SECTION 02713

EXTERIOR WATER DISTRIBUTION SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies furnishing, installing, testing and disinfecting permanent water supply and fire protection mains and distribution piping.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 02300 - EARTHWORK
2. Section 02650 - EXISTING SITE UTILITIES
3. Section 03300 - CAST-IN-PLACE CONCRETE

1.2 SUBMITTALS

A. Submit to the Engineer shop drawings showing the details, procedures, and scheduling for water utility Owner when the Authority's service line is ready for connection to utility Owner's piping. Shop drawings shall include maximum anticipated working pressure in each main and branch, the proposed pressure test pressure, and fittings material class.

B. Submit to the Engineer manufacturer's information for the meter pit and yard hydrants.

C. Submit to both the Engineer and the water utility Owner detailed hydrostatic test and disinfection plans, including all proposed materials, concentrations, equipment, temporary piping, valving, connections, flow rates, equipment, methods of metering and measuring, and method of flushing and disposal.

D. Submit to both the Engineer and the water utility Owner for acceptance all manufacturer's and independent laboratory certified test reports as specified above and in cited standards.

1.3 QUALITY ASSURANCE

A. Lining Toxicity Test

1. Procedure: FDA Method of Testing for Toxicity of Coating Material Intended for Use in Transporting or Holding Food or Potable Water.
2. Requirements: Certified test results by pipe manufacturer; no more than 18 mg. per square inch exposed surface and no more than 50 ppm by weight of the water capacity of the test container, of chloroform-soluble extractives, corrected for zinc extractives such as zinc oleate.

B. Field Pressure and Leakage Tests

1. Ductile Iron: AWWA C 600
2. Steel: AWWA C 600

C. Chlorine Residual Test

1. Test Method
   a. During Disinfection: AWWA Manual M12, APHA/AWWA Standard methods drop dilution, Method E.
   b. At End of Retention Period: APHA/AWWA Standard methods OTA or Amperometric Titration, Method D or F.
   c. After Post-Disinfection Flush: APHA/AWWA Standard Methods Amperometric Titration, Method F.
2. Requirements
   a. Test to be performed by approved independent testing laboratory. Certified test results to meet requirements of AWWA C 601 and water utility Owner.
   b. In lieu of independent testing laboratory, Contractor may subcontract for water utility Owner to conduct residual chlorine testing at Contractor's expense.

D. Bacteriologic Tests

1. Procedure: AWWA C 601 and APHA/AWWA Standard Methods.
2. Requirements: Zero coliform organisms, and meet requirements of water utility Owner and public health authority. Certified tests by approved independent testing laboratory or by public health authority at Contractor's expense.

1.4 JOB CONDITIONS

A. Relations with the Utility Owner – The Acton Water District

1. Establish through the Engineer a direct and continuous contact with the utility Owner to which the Authority's new distribution piping will be connected.
2. In all cases, verify from the utility Owner the maximum working pressure than can be encountered at point of interface with utility Owner's piping, and indicate this pressure on the shop drawings.
3. Do not cut into utility Owner mains or piping. The utility Owner will schedule and conduct interruption of utility services, perform cutting-in, and provide service meter at each point where new Authority piping is to be connected to the utility Owner mains and piping, at the expense of the Authority.
4. Do not connect to utility Owner meter or piping without written authorization from the utility Owner. Connection shall be made by the Contractor or utility Owner as indicated.
5. If agreed to by the utility Owner, the Contractor may, at his own expense, elect to have all or any part of the disinfection work performed by the utility Owner.

B. Cross-Connections: Do not connect or cross-connect Authority fire water distribution piping with other Authority water piping; except that suitable approved temporary cross-connections may be made for disinfection only, providing that all such temporary cross-connections are removed after disinfecting. Fire distribution piping may be disinfected separately from metered water distribution piping to eliminate need for cross connections.

C. Disinfection: Disinfect both domestic and service water piping and fire water piping.

PART 2 - PRODUCTS

2.1 PIPE

A. Ductile Iron Pipe: AWWA C 151 thickness class as indicated; double-thickness cement-mortar lined; with push-on or mechanical joints except where flanges are indicated.

B. Steel Pipe: AWWA C 200, type, grade, and thickness as indicated, lined, coated, wrapped and jacketed in accordance with AWWA C 203 with Type A primer, Type 2 enamel, standard swap and kraft jacket, plain ends for mechanical couplings, 8 inch band each end free of external coating and wrap.

C. Asbestos-Cement Pipe: AWWA C 400, Class 150, Type II.

2.2 FITTINGS

A. For Ductile Iron Asbestos-Cement Pipe, and all Transitions: AWWAA C 110; ductile iron; 150 psi minimum rating; cement-mortar lined; with mechanical joints except where flanges are indicated.

B. For Steel Pipe: ANSI B16.5; class as indicated; lined, coated, and wrapped as specified for steel pipe.

C. Couplings for Steel Pipe: Flexible mechanical couplings, primed with AWWA C 203 Type A Primer; with steel bolts bituminous coated.

2.3 FLANGES

A. For Ductile Iron Pipe: AWWA C 110, coated and lined as specified for iron pipe.

B. For Steel Pipe: Welded slip-on type flanges, ASTM A 181 or ANSI B16.5 150-pound standard flanged mechanical coupling adaptor, bituminous lined inside and AWWA Type A bituminous primed outside in accordance with AWWA C 203 requirements, flange to mate with AWWA C207, ANSI B16.1, or ANSI B16.5 flange as required; bituminous coated steel bolts.

C. Flange Gaskets: ANSI B16.21 neoprene, 1/8 inch thick.

2.4 VALVES

A. For Service and Domestic Water: Type and size as indicated, conforming to the following:

1. Yard Faucets and Miscellaneous through 2-1/2 inches: Approved MSS Standard globe and angle valves, malleable iron or cast bronze.
2. Gate, three inch and larger: AWWA C 500.
3. Butterfly, three inch and larger; AWWA C 504.
4. Check: AWWA C 506 double or approved commercial single.

B. For Fire Water: Type and size as indicated, Class as required, U.L. listed.

C. Valve Boxes: ASTM A48, 30B minimum, screw type adjustable length, stay-put type removable cover with the word WATER or FIRE as applicable.

D. Precast Vaults: ASTM C 139, air-entrained, and Section 03300 - CAST-IN-PLACE CONCRETE.

E. Cast-In-Place Vaults: Section 03300 - CAST-IN-PLACE CONCRETE, Class 4000-3/4.

F. Iron Castings: ASTM A48, 30B minimum, with lettering as indicated.

2.5 FIRE HYDRANTS

A. Hydrants shall conform to the "standard for Dry-Barrel Fire Hydrants" ANSI/AWWA C 502-85. Hydrants shall be designed for 150 psi service and for installation in a trench with 5 foot cover (5-1/2 feet bury hydrant). Hydrant barrel extensions shall be furnished and installed as necessary to achieve correct bury depth. The length of the hydrant barrel shall be such that when installed with the proper depth of cover on the branch pipeline, the hydrant will be set with the normal ground line of the barrel within 3-inches of the actual ground grade surface elevation.

B. Hydrants shall be fabricated to manufacturer's standard pattern and size and shall have one 4-1/2 inch steamer and two 2-1/2 inch hose nozzles all with National Standard Thread (NST). Hydrant inlet opening on shoe shall have mechanical joints for accepting 6-inch ductile or cast iron pipe.

C. Hydrants shall open clockwise and shall be marked with an arrow and word "OPEN" to indicate the direction of turn of the stem to open the hydrant.

D. Hydrants shall have a compression type main valve, opening against and closing with water pressure. The main valve opening at the base of the hydrant shall have a minimum area of 39 square inches (5-icnh minimum diameter circle). Each hydrant shall have "traffic" type ground line construction (breakaway bolts not acceptable) and permit 360-degree movement of the upper barrel to allow for any alignment without shutting down service and/or removing flange bolts and nuts. Hydrant operating nut shall be 1-1/2 inches, flat to point, pentagonal. Connecting pipe and pipe nipples between the main line tee and hydrant shall be 6-inch ductile iron conforming to the requirements for ductile iron pipe.

E. Hydrants shall be hydrostatically tested as specified in AWWA C 502.

F. Hydrant tees shall be anchor type. The branch shall have a plain end with an integral gland and rotating mechanical joint restraints. Every hydrant shall be equipped with a 6-inch shut-off valve, bolted or anchored to the hydrant tee.

2.6 SERVICE CONNECTIONS

A. As required by the municipality, the utility owner, or as specified in the Construction Specifications.

2.7 COUPLINGS

A. Pressure rating at least equal to that of related pipeline with a minimum rating of 150 psi.

B. Couplings shall be of a type equal to Smith Blair, Style 441; Dress, Style 153; 360 or Romac Style 501 or an approved equal. Couplings shall be provided with plain, Grade 27, rubber gaskets and with black steel, track-head bolts with nuts. Couplings shall be manufactured in the United States of America.

2.8 JOINTS

A. Provide mechanical joint or push-on joint pipe with necessary accessories, conforming to ANSI A21.11.

1. Provide gasket composition suitable for exposure to liquid within pipe.
2. Provide gasket composition suitable for exposure to potable water.
3. Provide mechanical joint gaskets with copper tips to provide electrical continuity.
4. Provide serrated brass wedges for push-on joints to provide electrical continuity; two per joint for pipe 12-in. and smaller and four per joint for larger pipe.

B. Restrained joints shall be furnished for installation on all fittings, sleeves, hydrants and valves. Restraints for mechanical joints shall be Megalug Series 1100 as manufactured by Ebaa Iron Co., Uni-flanged Series 1400 Mechanical Joint Restraint or equal. Restraints for push on joints shall be Series 1700 as manufactured by Ebaa Iron Co., or Series 1390 as manufactured by Uni-Flange.

C. Restraint systems for push-on pipe utilizing steel-wedge gaskets will be acceptable.

2.9 INSULATION

A. Insulation shall be manufactured by Thermal Pipe Systems, Braintree, Massachusetts, Atlas Insulation, Ayer, Massachusetts or Insulated Piping Systems, Inc., Canton, Massachusetts, or equal. Insulation shall be factory formed-in-place polyurethane foam insulation having nominal thickness of 3", with an in-place density of 2.5 pcf, and a "K" factor of 0.14 BUT/in./hr/deg. F/sq. ft. Straight joints between insulated pipe lengths, and the end section of non-insulated pipe shall be 20-gauge corrugated aluminum performed to be fastened with stainless steel screws and bands. Jackets shall have expansion joints at 25-foot intervals. Sections of jacket shall have 2-inch minimum at all seams.

B. Jacket shall have one layer of one mil polyethylene film with a protective coat of 40-lb. virgin draft paper to act as a moisture and galvanic corrosion barrier.

2.10 SERVICES

A. All services shall be Type K Copper Tubing.

2.11 CORPORATIONS, CURB STOPS AND SADDLES

A. The corporation stops shall meet the most recent revision of the AWWA standard "Threads for Underground Service Line Fittings" (AWWA C 800). Corporation stops shall be designed for 175 psi pressure and have full keyway and rigid liners.

B. Curb stops shall include a drain suitable for use with polyethylene tubing specified hereinbefore. Stops shall have integral checks, O-ring seal and shall be furnished with rigid liners.

C. Curb stop boxes shall be cast iron Buffalo type with recessed lid with pentagon bolt, adjustable sliding type.

D. Surface saddles for 2 inch taps shall be double strap with bodies of ductile iron. The straps shall be electrogalvanized carbon steel. Units shall be complete with Buna N gaskets.

2.12 TAPPING SLEEVES AND VALVES

A. Tapping sleeves shall be mechanical joint type.

B. Tapping valves shall meet the requirements of AWWA C 500. The valves shall be flanged by mechanical joint outlet with non-rising stem and designed for vertical burial. Tapping valves shall be rated at 200 psi working pressure and shop tested at 300 psi. Bolts on bonnet and stuffing box shall be stainless steel (316 stainless steel), stuffing boxes shall be "O" ring type. The operating nut shall be 2-inches square. The valve shall be provided with oversized seat to permit use of full size cutters. Gaskets shall cover the entire flange surface. Valves shall open right (clockwise).

C. Valves shall be Mueller H-667 or approved equal.

D. Valve boxes shall be provided for each gate valve and tapping sleeve and valve.

2.13 YARD HYDRANTS AND METER PITS

A. Yard hydrants and meter pits shall be as detailed in the contract drawings. The water meter and backflow preventer shall conform to the requirements of the utility owner.

PART 3 - EXECUTION

3.1 EXCAVATIONS

A. Conform to the requirements of Section 02300 - EARTHWORK and the AWWA Standards and Manual cited herein.

B. Dewater as required and disinfect excavation in accordance with Section 11 of AWWA C 601 where required.

3.2 INSTALLATION

A. Vaults: Install vaults as indicated. Provide six inches of backfill sand bedding for precast vaults. Construct cast-in-place vaults generally as specified for manholes, Section 02400 - DRAINAGE AND SEWER SYSTEMS. Provide pervious backfill subdrains and drainage as indicated or required for proper drainage.

B. Pipe Laying:

1. Install ductile iron pipe, fittings, and valves in accordance with AWWA C 600. Install steel pipe, fittings, and valves in accordance with AWWA C 200 and AWWA Manual M11. Install asbestos cement pipe in accordance with AWWA C 603.
2. Inspect all pipe, fittings and valves for soundness and for imperfections of coatings, wrappings and linings prior to installation.
3. Deflection at joints shall not exceed the maximum recommended by the pipe or coupling manufacturer for each type of coupling and each size of pipe.

4. Blocking will be permitted only where indicated.
5. Field welding will be permitted only where specifically authorized. Pipe may be cut in the field by approved means. After welding or cutting, repair damage to linings and coatings and prime and inspect the cut surface as specified in AWWA C 203, Section 2.14. Repair damaged cement linings in accordance with AWWA C 602 Section 16, or discard the pipe.
6. Prime steel pipe couplings and exposed pipe ends before installation, but do not enamel or wrap until after hydrostatic leak test.
7. Install all temporary piping, valving, meters, gages, and equipment required for hydrostatic testing and disinfection in accordance with approved shop drawings.

C. Anchorages and Buttresses

1. Construct concrete anchorages and buttresses where indicated. The soil bearing area shall not be less than indicated.
2. Harness all valves and fittings not provided with an anchor, buttress or restrained joint with steel rods and rod socket pipe clamps or by steel rods and rod connectors connected to mechanical joint bolts as indicated.

D. Fittings and valves shall be restrained for the minimum lengths listed on the following table:

MINIMUM RESTRAINED LENGTHS

FITTING	RESTRAINT LENGTH
12" – 45° Bend	13-feet in each Direction
8" – 45° Bend	9-feet in each Direction
6" - 45° Bend	7-feet in each Direction
12" – 22-1/2° Bend	6-feet in each Direction
10" - 45° Bend	11-feet in each Direction
8" - 90° Bend	23-feet in each Direction
8" – 22-1/2° Bend	4-feet in each Direction
8" – 11-1/4° Bend	2-feet in each Direction
6" – 22-1/2° Bend	3-feet in each Direction
6" – 11-1/4° Bend	2-feet in each Direction
12" – 11-1/4° Bend	3-feet in each Direction
12" Vertical Offset	
Upper 45° Bend	27-feet in each Direction
Lower 45° Bend	12-feet in each Direction
8" Vertical Offset	
Upper 45° Bend	19-feet in each Direction
Lower 45° Bend	8-feet in each Direction
6" Vertical Offset	
Upper 45° Bend	14-feet in each Direction
Lower 45° Bend	6-feet in each Direction
12" x 12" x 12" Tee	42-feet in Branch
12" x 12" x 10" Tee	29-feet in Branch
12" x 12" x 8" Tee	16-feet in Branch
12" x 12" x 6" Tee	1-foot in Branch

8" x 8"x 8" Tee	25-feet in Branch
8" x 8" x 6" Tee	10-feet in Branch
8" x 8" x 4" Tee	1-foot in Branch
6" x 6" x 6" Tee	15-feet in Branch
6" x 6" x 4" Tee	1-foot in Branch
16" x 12" Reducer	32-feet Larger Direction only
12" x 10" Reducer	28-feet Larger Direction only
12" x 8" Reducer	31-feet Larger Direction only
12" x 6" Reducer	42-feet Larger Direction only
8" x 6" Reducer	17-feet Larger Direction only
8" x 4" Reducer	29-feet Larger Direction only
6" x 4" Reducer	16-feet Larger Direction only
12" Valve or Dead-end	58-feet in each Direction
10" Valve or Dead-end	49-feet in each Direction
8" Valve or Dead-end	41-feet in each Direction
6" Valve or Dead end	31-feet in each Direction
4" Valve or Dead-end	22-feet in each Direction
2" Valve or Dead-end	18-feet in each Direction

1. Lengths shown are based on 150 psi test pressure, 4-1/2-foot bury, soil type GP, trench Type 3, and 2:1 safety factor. Changes in conditions will require revision in lengths.

3.3 TESTING AND DISINFECTING

A. Hydrostatic Tests

1. Conduct both pressure test and leakage test by the open trench method as specified in AWWA C 600. Conduct leakage test as soon as practicable after completion of the pressure test.
2. Conduct all hydrostatic tests in the presence of the Engineer, and prior to coating joints and disinfecting. Do not conduct any hydrostatic tests until after all associated concrete work has cured for a minimum of 7 days for standard concrete and at least 36 hours for high early strength concrete.
3. As soon as practicable after completion of hydrostatic tests, drain lines in an approved manner, and disconnect and remove temporary test piping and equipment which will no longer be required.

B. Field Coating. After completion of hydrostatic tests and before disinfecting, prime or reprime as required and coat all uncoated metal components of the piping system, including joints, harnesses and tie rods, generally as specified in AWWA C 201 for mechanical couplings, except that exposed ends of steel pipe up to the coupling shall be wrapped with hot applied coal tar tape. Inspect field-applied bituminous coatings for holidays as specified in AWWA C 203.

C. Disinfection. Disinfect and test all lines in accordance with the requirements of AWWA C 601 and as specified herein. Disinfect before final backfill around hydrants and valves. Remove disinfection equipment and temporary piping after approval of the disinfection tests.

D. Operating Tests. Following approval of the disinfection, conduct operating tests in the presence of the Engineer to verify that each valve and hydrant is in proper working condition. Whenever practicable, conduct operating tests during flushing of chlorine from the line.

3.4 BACKFILLING

A. Conform to the requirements of Section 02300 - EARTHWORK and the AWWA standards and Manuals cited herein.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Pipe including fittings will be measured per linear foot for each type and size, along the centerline with deductions for valves.

B. Vaults, hydrants, valves, tapping sleeves and valve boxes shall be measured per each by type and size.

C. Bedding material, porous fill, joints, couplings, fittings, tie rods, rod, couplings, pipe clamps, coatings, and hydro static testing will not be measured separately for payment and shall be considered incidental to the item of work for which it pertains.

D. Excavation and backfill materials shall be measured in accordance with Section 02300 - EARTHWORK. Concrete shall be paid for in accordance with Section 03300 - CAST-IN-PLACE CONCRETE.

E. Yard Hydrants and meter pits shall be measured per each complete in place including excavation , bedding, backfill, and all labor, materials, equipment and incidentals necessary to satisfactorily complete the work

4.2 PAYMENT

A. Water Meter Pits: Water Meter Pits shall be paid for at the Contract unit price per each pit complete in-place as shown on the Drawings. Payment shall be full compensation for all labor, materials, and equipment required.

B. Water Line: Pipe for the exterior water distribution system shall be paid for at the Contract unit price per linear foot of piping installed complete in-place by size and type. Payment shall be full compensation for all labor, materials, and equipment required piping in the sizes and types shown on the Drawings.

C. Yard Hydrants: Yard Hydrants shall be paid for at the Contract unit price per each yard hydrant complete in-place. Payment shall include all labor, materials, and equipment required.

D. Tapping Sleeve, Valve, and Box: Tapping Sleeves and the associated valve and valve box shall be paid for at the Contract unit price per each tapping sleeve complete in-place. Payment shall be full compensation for all labor, materials, and equipment required to install tapping sleeves in sizes and locations shown on the Drawings including access pipe, tapping gate valve, masonry foundations, and the cast iron frame and cover.

E. Excavation, Backfill and Gravel installed as part of the exterior water distribution systems shall be shall be paid for in accordance with Section 02300 - EARTHWORK. Concrete installed as part of exterior water distribution systems shall be paid for in accordance with Section 03300 - CAST-IN-

PLACE CONCRETE. Utility Structure Adjusted as part of exterior water distribution systems shall be paid for in accordance with Section 02650 - EXISTING SITE UTILITIES.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0255.702	WATER METER PITS	EA
1521.617	2" TYPE K COPPER WATER LINE	LF
1550.130	YARD HYDRANT – FURNISH AND INSTALL	EA
1520.402	6"x 3" TAPPING SLEEVE VALVE & BOX	EA

END OF SECTION

SECTION 02900
TREES, SHRUBS AND GROUNDCOVERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies furnishing and installing trees, shrubs, and groundcovers as indicated on the Drawings and as specified herein.

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

C. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

1.2 WORK TO BE PERFORMED

A. The scope of the work, without limiting the generality thereof, consists of furnishing all labor, materials and equipment for the following items of work and all work incidental thereto as shown on the Drawings and as herein specified.

1. Installation of trees, shrubs, and groundcovers.
2. Installation of erosion control devices in planting beds as required.
3. Protection, maintenance and guarantee of planted areas.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. For furnishing and placing loam and planting soil mix for lawns and planting areas, see Section 02923, Landscape Grading.

B. For erosion control of seeded areas see Section 02485, Seeding and Sodding.

1.4 REFERENCES, STANDARDS, AND SPECIFICATIONS

A. "Standardized Plant Names:" American Joint Committee on Horticultural Nomenclature, 1942 Edition.

B. "American Standard for Nursery Stock", American Association of Nurserymen, 1973 Edition (ANS).

1.5 SUBMITTALS

A. Nursery source(s) of plant materials, and certification of specification compliance by nursery.

B. Proposed maintenance program for plants during one-year guarantee period.

C. Erosion Control Matting - Manufacturers literature and two (2) samples 12" x 12".

D. Aged Pine Bark Mulch - Quart size resealable bag.

E. Manufacturer's literature for slow release fertilizer tablets.

PART 2 - PRODUCTS

2.1 LOAM

A. Loam for planting soil mix backfill for trees and shrubs shall meet the specifications of Section 02923, Landscape Grading.

2.2 PLANTING SOIL MIX

A. Planting Soil Mix for backfilling of shrub and tree planting pits shall be as required for Planting Soil Mix in Section 02923 Landscape Grading.

2.3 SLOW RELEASE FERTILIZER TABLETS

A. Slow release planting tablets: Fertilizer shall be provided for each plant through the use of tightly compressed, long-lasting, slow-release fertilizer tablets which are designed and certified by the manufacturer to provide controlled release of fertilizer over a minimum two (2) year period. Each tablet shall consist of 21 grams of water soluble fertilizer with a minimum guaranteed analysis as follows:

Total Nitrogen	20%
7% water soluble N	
13% water insoluble N	
Available Phosphoric Acid	10%
Available Potash	5%
Calcium	2.8%
Magnesium (water insoluble)	0.5%
Sulfur	2%
Boron	0.02%
Copper	0.05%
Iron	0.5%
Manganese	0.05%
Zinc	0.05%

2.4 EROSION CONTROL MATERIAL

A. Erosion control matting for planting beds sloped 3:1 or greater shall be jute mesh as specified in Section 02485 Seeding and Sodding.

2.5 MISCELLANEOUS MATERIALS

A. Mulch shall be dark brown, aged shredded pine bark mulch which has not been dyed, passing one inch square mesh and retained on 1/8 inch square mesh. It shall be free of long stringy material.

B. Water necessary for planting operations and maintenance shall be supplied and paid for by the Contractor. Contractor shall furnish his own hose and hose connections from the outlets where water is available.

C. Tree stakes shall be type, dimensions, and quantity as shown on the drawings.

D. Guying wires shall be as shown on the Drawings.

E. Wrapping materials shall be standard manufactured tree wrapped paper, brown in color with crinkled surface and fastened by use of organic twine ties.

F. Hose shall be new 2 ply reinforced black rubber garden hose not less than ½ inch diameter of length suitable to protect the tree. Turnbuckles where required shall be galvanized having a 3 inch minimum lengthwise opening fitted with screw eyes.

G. Provide one (1) sample of fertilizer in manufacturer's packaging and two (2) certificates showing composition and analysis.

2.6 PLANT MATERIALS

A. All plants shall conform to ANS standards. Plants shall be of high quality, heavy, symmetrical, tightly knit plants, 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 last two years.

2. Plants shall be freshly dug. No heeled-in plants or plants from cold storage will be accepted.

3. Plants shall comply with all applicable State and Federal Laws with respect to inspection for plant diseases and infestations. They shall be free from physical damage or adverse conditions that would prevent thriving with the specified result. They 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 root systems.

4. 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.

5. 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 their otherwise full compliance with ANS Standards.

6. Shrubs of a single variety shall be matched specimens from a single block source unless otherwise noted.

B. Substitutions of plant materials will not be permitted unless authorized in writing by the Engineer.

C. Label all plants. Plant material labels shall be durable, legible labels stating the correct plant name and size using weather resistant ink or embossed process. Attach securely to all plants, bundles, and containers of plant material delivered being careful that those attached directly to plants will not restrict growth.

D. Selection of Nursery Stock

1. At least 20 days prior to the expected planting date, the Contractor shall request, in writing, that the Authority provide a representative to select and tag all trees to be planted under this section. At the discretion of the Authority, groundcovers and shrubs shall also be selected and tagged by

the Authority's representative. This request shall be made 10 days prior to the date on which stock selections are to be made. The letter of request shall also have attached a letter of certification from the supplier attesting to the fact that the stock to be selected from is, in fact, the patented tree required under this Section.

2. The Contractor shall arrange for and bear the cost of transportation, meals in transit, and overnight accommodations, if necessary, for the Authority's representative during the period of time required to select and tag the required number of sized stock.

E. Plants shall be subject to approval by the Engineer upon delivery for conformity to specification requirements.

F. Balled and burlapped (B&B) plants shall have firm natural balls of earth of diameter not less than that recommended by the "American Standard for Nursery Stock", and of sufficient depth to include the fibrous and feeding roots. All plants which are six inches in caliper or over shall be double burlapped.

1. All plant material being transported shall be covered while in transit.
2. Plants moved with a ball will not be accepted if the ball is cracked or broken before or during planting operations.

G. Rejected plants will be removed immediately from the site by the Contractor.

2.7 WATER

A. The Contractor shall be responsible for supplying all water necessary for the work of this section including installation and maintenance of planting until final acceptance.

B. Water shall be clean and free of substances harmful to plants, animals and humans.

PART 3 - EXECUTION

3.1 PREPARATION OF SITE - GENERAL

A. Verify that planting beds have been prepared according to the requirements of Section 02923 - Landscape Grading. Prior to planting operations, the Contractor shall request an inspection be made of the finished loam and planting bed areas. No planting shall take place until the Engineer approves the topsoil grade. All planting areas shall be sloped to drain. Finished surfaces shall be corrected to eliminate depressions holding water. Contractor shall confirm to the Engineer that all proposed tree pits have been over-excavated and backfilled per Drawings prior to planting. The commencement of work by the Contractor shall indicate his acceptance of the areas to be planted, and he shall assume full responsibility for the work of this Section.

3.2 TREES AND SHRUBS PLANTING OPERATIONS

A. Planting Season: Planting shall be done within the following dates:

Deciduous & Perennial Plants: Sept. 1 to Dec. 15
March 15 to May 15

Bulbs: Oct. 1 to Nov. 15

Evergreen Plants: Sept. 1 to Nov. 15

March 15 to May 15

1. If special conditions exist, which may warrant a variance in the above planting dates, a written request shall be submitted to the Engineer stating the special conditions and the proposed variance. Permission for the variance will be given if, in the opinion of the Engineer, the variance is warranted.

B. The Contractor shall inform the Engineer when planting will commence, anticipated delivery date of material and shall have made and provided for the staking of all plants and plant beds. Failure to notify the Engineer 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.

C. Loam Stockpile: Maintain at all times during the planting operations one or more loam stockpiles of approved quality loam for tree pits and shrub and groundcover beds.

D. Excavation of Plant Pits:

1. Stake out on the ground locations for plants and obtain approval of the Engineer before excavation is begun.
2. Establish finish grades for shrub and groundcover beds. Excavate and regrade subgrade as necessary. Separate subgrade soils from the upper "Topsoil" portions and remove immediately wherever encountered during planting operations. Loosen top six inches of subgrade in pits and beds immediately prior to placing planting soil.
3. Notify the Engineer in writing of all soil or drainage conditions which the Contractor considers detrimental to the growth of plant material.

E. Protect plants at all times from sun or drying winds. Plants that cannot be planted immediately on delivery shall be kept in the shade, well protected with soil, wet moss or other acceptable material and shall be kept well watered. Plants shall not remain unplanted for longer than three days after delivery.

F. Plants shall not be bound with wire or rope at any time so as to damage bark or break branches. Plants shall be lifted and handled from the bottom of the ball only. All plant roots and earth balls shall be kept damp and thoroughly protected from sun and drying winds at all times.

G. Set plants at same relationship to finished grade as they bore to the ground from which they were dug, but with the trunk flare exposed. After settlement, the crown of the plant ball shall be one (1) to two (2) inches higher than the surrounding finished grade. Planting soil shall be backfilled in layers of not more than nine inches and each layer shall be tamped before the next layer is placed. When plant beds have been backfilled approximately 2/3 full, water thoroughly before installing remainder of the 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 Engineer.

H. Planting shall be set 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.

I. Remove wire wrap from root balls. Do not leave any portion of wire wrap in planting pit. Cut ropes or strings from the top of the balls after the plant has been set. Cut off or fold back and bury burlap from top 2/3 of root ball. Remove plastic twine and burlap completely.

J. Mulch and water all plants immediately after planting.

K. Smooth planting areas to conform to specified grades after full settlement has occurred and mulch has been applied.

L. Fertilizing Schedule

1. Provide slow release planting tabs in the quantity recommended by the fertilizer manufacturer for the species and size of tree and shrub involved.

M. Pruning: Prune new plants only at time of planting and in accordance with the 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 Engineer.

1. Remove all dead wood, suckers and broken or badly bruised branches. Do not cut leader. Use only clean sharp tools.

N. Only trees specified on the Drawings shall be guyed and anchored at the time of planting. Guys shall be placed around the trunk in such a manner that no branches will be subject to undue strain. Wires shall not come in direct contact with the bark of a tree. Guys shall be kept tight at all times.

3.3 EROSION CONTROL

A. Erosion control matting shall be installed over all planting beds with a slope of 3:1 or greater.

B. It shall be the responsibility of the Contractor to provide any additional erosion control measures to render all planting areas erosion free throughout the construction period. The Contractor may accomplish this by any of several alternate methods, any of which may be used provided such method is acceptable to the Engineer. Approval of the method by the Engineer does not free the Contractor of responsibility for controlling erosion.

3.4 PROTECTION AND MAINTENANCE OF PLANT MATERIAL

A. Protection and maintenance shall begin immediately after each plant is planted 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 and furnishing and applying such sprays as are necessary to keep the plantings free of insects and disease. Pesticides shall be approved by the Engineer prior to use and shall be used in accordance with the specifications of the prevailing Public Health Authority.
2. Planting areas and plants shall be protected at all times against trespassing and damage of all kinds for the duration of the maintenance period. If any plants become damaged or injured, they shall be treated or replaced as directed by the Engineer at no additional cost to the Owner.
3. All trees shrubs and plants shall be watered twice within the first 24 hours of planting and at least twice each week thereafter. The soil around each tree or shrub shall be thoroughly saturated. Trees shall receive a minimum of ten gallons of water each, and shrubs a minimum of five gallons each at each watering.

B. Upon completion of planting and prior to acceptance, the Contractor shall remove excess soil and debris from the site and repair any damage to structures, pavements, lawns, etc., resulting from planting operations at no additional cost.

C. Full and complete written instructions for maintenance of the plantings shall be furnished by the Contractor to the Authority within 10 days after the planting of the first plant.

3.5 INSPECTION

A. When planting is substantially complete, the Contractor shall request in writing that the Engineer inspect all work. After such inspection the Engineer shall submit a final punchlist to the Contractor.

3.6 PRELIMINARY ACCEPTANCE (START OF ONE YEAR GUARANTEE)

A. After all necessary corrective work and clean-up have been completed and maintenance instructions have been delivered to the Authority, Preliminary Acceptance of the planting shall be given by the Owner after the Engineer has determined that all work of the planting, including written guarantees and including all items on the final punchlist, have been completed and that all work conforms to the Contract Documents.

B. The Engineer shall certify in writing to the Authority as to the preliminary completion of the project.

C. Acceptance of plant material by the Engineer shall be for general conformance to specified size, character and quality and shall not relieve the Contractor of responsibility for full conformance to the contract documents including correct species.

3.7 GUARANTEE PERIOD AND REPLACEMENTS

A. All trees, shrubs and groundcovers shall be guaranteed by the Contractor for a period of one year. The guarantee period shall begin on the date of preliminary acceptance of the planting. Plants shall be alive and in satisfactory growth at the end of the guarantee period.

B. The Contractor shall provide maintenance for plant materials during the guarantee period and shall submit to the Authority for review and approval, a proposed maintenance program. The Contractor shall make periodic inspections as necessary, at no extra cost to the Authority, during the guarantee period to determine what changes, if any, should be made to the Maintenance Program. Any changes should be submitted in writing to the Engineer. The Contractor, at his option, may provide additional maintenance. In either case, the Contractor will be responsible for replacement of any dead or damaged plants at the end of the guarantee period.

C. The Contractor shall replace, without cost to the Authority, and as soon as weather conditions permit and within specified planting period, all dead plants and all plants not in vigorous, thriving condition, as determined by the Engineer during and at the end of the guarantee period. The 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.

D. The Contractor shall make all necessary repairs due to plant replacements. Such repairs shall be done at no extra cost to the Authority.

E. The guarantee of all replacements 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 the extended guarantee period, the Authority may elect subsequent replacement or credit for each item.

F. The guarantees shall be in writing, signed by the Contractor, in a form acceptable to the Authority.

3.8 FINAL INSPECTION AND FINAL ACCEPTANCE

A. At the end of the guarantee period, the Engineer shall inspect all guaranteed work for final acceptance upon written request of the Contractor. The request shall be received at least 10 calendar days before the anticipated date for final inspection.

1. Prior to final acceptance of the planting, the Contractor shall remove and dispose of all guying and staking material from trunks of trees.

B. Upon completion and re-inspection of all repairs or replacements necessary, in the judgment of the Engineer at that time, the Engineer shall certify in writing to the Authority as to the final acceptance of this portion of work.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

Separate measurement and payment will not be made for work of this Section, complete in place, but all costs therefore will be included in the Contract Lump Sum Price for Landscaping.

4.2 PAYMENT ITEMS

Item No.	Description	Unit
0276.000	LANDSCAPING	LS

END OF SECTION

SECTION 02920

LAWNS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies the following items:

1. Seeding.
2. Sodding.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 02100 – SITE PREPARATION; topsoil stripping and stockpiling.
2. Section 02300 – EARTHWORK; excavation, filling and backfilling, and rough grading.

1.2 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

C. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

D. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging. Certification of each seed mixture for sod, identifying source, including name and telephone number of supplier.

C. Product Certificates: For soil amendments and fertilizers, signed by product manufacturer.

D. Qualification Data: For landscape Installer.

E. Material Test Reports: For existing surface soil and imported topsoil.

F. Planting Schedule: Indicating anticipated planting dates for each type of planting.

G. Maintenance Instructions: Recommended procedures to be established by Authority for maintenance of lawns during a calendar year. Submit before expiration of required maintenance periods.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn establishment. Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.

B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of topsoil.

D. Topsoil Suitability: Report suitability of topsoil for lawn growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce a satisfactory topsoil.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in TPI's "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in its "Guideline Specifications to Turfgrass Sodding."

1.6 SCHEDULING

A. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit. Do not plant during inclement weather including but not limited to heavy rain, high winds, frost and similar conditions.

1.7 LAWN MAINTENANCE

A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:

1. Seeded Lawns: 60 days from date of Substantial Completion.

    a. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.

2. Sodded Lawns: 30 days from date of Substantial Completion.

B. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.

C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water lawn at a minimum rate of 1 inch per week.

D. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 40 percent of grass height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the 1-1/2 inch grass height or less.

E. Lawn Postfertilization: Apply fertilizer after initial mowing and when grass is dry. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to lawn area.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with Association of Official Seed Analysts' "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

1. Proportioned by weight as follows: <Insert species>.

2.2 TURFGRASS SOD

A. Turfgrass Sod: Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with TPI's "Specifications for Turfgrass Sod Materials" in its "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

B. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

1. Species: <Insert species>.

2.3 TOPSOIL

A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.

1. Topsoil Source: Import topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from agricultural land, bogs or marshes.
2. Topsoil Source: Amend existing in-place surface soil to produce topsoil. Verify suitability of surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
   a. Surface soil may be supplemented with imported or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from agricultural land, bogs or marshes.

2.4 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent.

B. Aluminum Sulfate: Commercial grade, without additives.

C. Sand: Clean, washed, natural or manufactured, free of toxic materials, gradation suitable for use.

2.5 PLANTING ACCESSORIES

A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

2.6 FERTILIZER

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.7 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

B. Erosion-Control Fiber Mesh: Biodegradable twisted jute or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

2.8 PLANTING SOIL MIX

A. Planting Soil Mix: Topsoil mixed with suitable soil amendments and fertilizers.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding overspray.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 LAWN PREPARATION

A. Limit lawn subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 8 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Authority's property.

C. Unchanged Subgrades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least of 8 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 6 inches of soil. Till soil to a homogeneous mixture of fine texture.
3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
4. Legally dispose of waste material, including grass, vegetation, and turf, off Authority's property.

D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll to grade and rake, remove

ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future.

E. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.4 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged.

B. Sow seed at the rate of 3 to 4 lb/1000 sq. ft.

C. Rake seed lightly into top 1/8 inch of topsoil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes exceeding 1:6 with erosion-control fiber mesh and 1:4 with erosion-control blankets installed and stapled according to manufacturer's written instructions.

3.5 HYDROSEEDING

A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with nonasphaltic tackifier.
2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply mulch at a minimum rate of 1500-lb/acre dry weight but not less than the rate required to obtain specified seed-sowing rate.

3.6 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across angle of slopes exceeding 1:3.
2. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.7 SATISFACTORY LAWNS

A. Satisfactory Seeded Lawn: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 5 by 5 inches.

B. Satisfactory Sodded Lawn: At end of maintenance period, a healthy, well-rooted, even-colored, viable lawn has been established, free of weeds, open joints, bare areas, and surface irregularities.

C. Reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

3.8 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.

C. Remove erosion-control measures after grass establishment period.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. No separate measurement will be made for lawns and grasses, but all costs in connection therewith shall be included in the lump sum price for lawns and grasses except as otherwise noted. All preparation and incidental work necessary to accomplish the installation will be considered incidental to the Lump Sum price.

4.2 PAYMENT

A. Payment for lawns and grasses will be made at the Contract lump sum prices as specified above.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0282.001	LAWNS AND GRASSES	SF

END OF SECTION

SECTION 03254

ELASTOMERIC BEARING PADS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies elastomeric bearing pads for railroad bridge structures, pre-cast concrete panels, and pedestrian bridge structures.

1.2 SUBMITTALS

A. Submit manufacturer's literature or shop drawings for products provided under this Section.

1. The Contractor shall submit bridge bearing shop drawings to the Engineer for review and approval. Fabrication of the bearings shall not begin until the Contractor receives approved shop drawings. The drawings shall include, but not be limited to the following.
   a. Plan and elevation of each bearing type and size
   b. Complete bearing assembly details and sections showing all materials (with ASTM or other designations) incorporated in the bearings.
   c. All fabrication dimensions and required surface finishes.
   d. Vertical and horizontal load capacities.
   e. Shop coating requirements.
   f. Bearing seat and all bearing anchorage details.

B. Certificate of Compliance

1. The Contractor's bearing supplier shall submit Certificates of Compliance for the bearings indicating the materials, fabrication, testing, and installation are as specified herein.

C. Samples: Furnish one sample elastomeric bearing pad for each type of pad used in the work for destructive testing. Samples will be selected by the Engineer at random from the lots delivered to the project site.

1.3 QUALITY ASSURANCE

A. Test specimens will be cut from the sample elastomeric bearing pads and will be tested for conformance to these Specifications. For such test specimens a reduction of 10% in the minimum requirements for original tensile strength and ultimate elongation will be permitted.

B. Hold Point - Do not set elastomeric bearing pads in place until the samples have been tested and approved by the Engineer.

C. Welding Qualifications

1. Welds shall be made only by welders who are qualified by tests as prescribed by AWS D1.5 to perform the type of work required.

D. Tests and Inspection

1. Production bearing sampling and testing shall be performed in accordance with the more stringent of AREMA, Chapter 15, Part 11, and AASHTO Division II, Section 18.7, as applicable.
2. Each bearing shall be visually examined both during and after testing. Any resultant defects, such as bond failure, physical destruction or debonding, shall be cause for rejection. Defects such as extruded or deformed elastomer or cracked steel shall also be cause for rejection.

1.4 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Every bearing shall have the Project Identification Number, Lot Number, and Individual Bearing Number indelibly marked with ink.

B. After assembly including sole plates, bearing components shall be held together with steel strapping or other means, to prevent disassembly until the time of installation. Packaging shall be adequate to prevent damage from impact as well as from dust and moisture contamination during shipping and storage.

C. Bearings delivered to the site shall be stored under cover on a platform above the ground surface. Bearing shall be protected at all times from damage. When placed, bearings shall be dry, clean, and free from dirt, oil, grease, or other foreign substances.

D. Bearing assemblies shall not be disassembled unless otherwise permitted by the Engineer or Manufacturer.

PART 2 - PRODUCTS

2.1 ELASTOMERIC BEARING PADS

A. Type: Either plain bearing pads, consisting of elastomer only, or laminated bearing pads, consisting of layers of elastomer restrained at their interfaces by bonded laminates, as indicated.

B. Elastomer portion of the elastomeric compound: 100% virgin chloroprene.

C. Plain Type: Molded individually cut from previously molded strips or slabs, or extruded and cut to length: cut edges at least as smooth as ANSI 250 finish.

D. Laminated Type: All components laminated bearing pads molded together into an integral unit and all edges of the non-elastic lamination covered by a minimum of 1/8 inch of elastomer -except at laminate restraining devices and around holes that will be entirely closed on the finished structure. Laminates: rolled mild steel sheets conforming to ASTM A 36, A 570, Grade C or D or A61 1, Grade C or D.

E. Physical Requirements

1. Finish, appearance, flash, and rubber to metal bonding, as defined in Rubber Manufacturers Association Handbook:
   a. Thickness: no undersize and not more than 10% oversize.
   b. Length and Width: As indicated, plus or minus 1/8 inch
   c. Finish: commercial finish (Table V. Symbol F.3)
   d. Flash: tear trim tolerance (Table VI. Symbol T.063)

e. Rubber-to-Metal Bonding (min.): 40 pounds per inch width (Grade 2. Method B. Table VIII).

2. Static load deflection: for any layer of elastomeric bearing, 7% maximum 800 psi average unit pressure when tested under laboratory conditions.

3. Physical Properties
   a. Hardness, per ASTM D 2240: 60, plus or minus 6
   b. Tensile strength, per ASTM D 412: 2500 psi minimum
   c. Ultimate elongation, per ASTM D 412: 350% minimum

4. Heat Resistance per ASTM D 573, 70 hours at 212° F.
   a. Change in durometer hardness: plus 15 points maximum
   b. Change in tensile strength: minus 15% maximum
   c. Change in ultimate elongation minus 40% maximum

5. Compression set, per ASTM D 395, Method B, 22 hours at 212°F: 35% maximum

6. Ozone cracking, per ASTM Dl 149, 100-pphm ozone in air by volume, 20% strain, 100 plus or minus 2°F, 100 hours, mounting procedure A per ASTM D 518: no cracks.

7. Adhesion, per ASTM D429, Method B, bond made during vulcanization: 40 pounds per inch.

8. Low Temperature Test
   a. Sample preparation: 96 hours at-20 plus or minus 2°F, axial load 500 psi strain of 20% effective rubber thickness.
   b. Shear resistance after one hour at 25% shear strain: 75 psi maximum.

2.2 STRUCTURAL STEEL

A. All masonry plates and sole plates shall conform to the requirements of ASTM A709 Grade 50.

B. All steel angles for fastening pre-cast panels to pier caps shall conform to the requirements of ASTM A709 Grade 50.

2.3 ADHESIVE FOR BONDING

A. Epoxy Material, Fed. Spec. MMM-A-134, FEP Film or Equal.

2.4 PREFABRICATED PAD

A. Rubber-Cotton Duck Pad 1/8" thick, in accordance with AREMA, Section 15, Part 11 (11.2.4.4b).

2.5 FASTENERS

A. All Anchor Bolts shall conform to the requirements of ASTM F1554, Grade 105

2.6 PROTECTIVE COATING

A. Steel for Bearing Assemblies shall be Hot-Dip Galvanized as applicable.

B. Plates and Bars: ASTM A123

C. Anchor Rods, Nuts, and Washers: ASTM A153

PART 3 - EXECUTION

3.1 GENERAL

A. Install elastomeric bearing pads in accordance with the details contained in the Contract Drawings. Make any adjustments required to install the bearing pads in the correct horizontal and vertical location.

3.2 FABRICATION

A. The Sole Plate shall be galvanized, except for the 1" wide strips where the sole plate is to be welded to the girder bottom flange.

B. Welding: In accordance with AASHTO/AWS D1.5

C. Gross bearing dimensions shall a tolerance of –0, +1/8".

3.3 INSTALLATION

A. Bearings for pre-cast concrete platform panels shall be fabricated and installed in accordance with Section 03410 – Plant -Precast Structural Concrete.

B. Bearings for pedestrian ramp/bridge structures shall be set such that no horizontal bearing deformation exists at 50-degrees F.

C. Bearings for bridge structures shall be set such that no horizontal bearing deformation exists at 50-degrees F.

1. Temperature of steel adjacent to the bearing during field welding shall be kept below 250-degrees F.
2. Sole plate-to-bottom flange welds shall terminate ¼" from edge of plate.
3. After welding, apply a galvanizing repair paint with a minimum dry film thickness of 3-mils to the welds and bare strips.
4. Bearing assemblies shall be installed in accordance with the bearing alignments shown on the contract plans. Upon final installation of the bearings, the Engineer and Manufacturer's representative shall inspect the bearing components to assure that they are level and aligned to within +/- 0.005 radians. Any deviations in excess of the allowed tolerances shall be corrected.
5. Bearing assemblies shall be handled by their bottom surfaces only. The bearings shall not be lifted by their tops, sides and/or shipping bands.
6. The bearing assemblies shall be aligned with the superstructure as shown on the plans. On expansion bearings, special care must be taken to properly align the bearing with the designated expansion direction of the structure as shown on the plans.

D. Bearings for precast concrete deck beams and precast prestressed concrete box beams shall be fabricated and installed in accordance with Section 03410 – Plant-Precast Structural Concrete.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Elastomeric bearing pads for railroad bridges will be measured per each installed in the work.

B. Separate Measurement and Payment will not be made for Elastomeric Bearing Assemblies used for pedestrian bridges/structures and precast concrete platforms panels complete in place, but all costs in connection therewith shall be included in the Contract Lump Sum Price for Item 0613.019 – Access Platform.

4.2 PAYMENT

A. Elastomeric bearing pads for railroad bridges will be paid for at the Contract unit prices for the quantities determined as specified above.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0343.150	ELASTOMERIC BEARINGS	EA
0613.019	ACCESS PLATFORM	LS

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies the following items:

1. Cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures and finishes for the following applications:
   a. Footings.
   b. Foundation walls.
   c. Slabs-on-grade.
   d. Suspended slabs.
   e. Concrete toppings.
   f. Building frame members.
   g. Building walls.
   h. Cutting and patching of mechanical and electrical penetrations through cast-in-place concrete.
   i. Abutment caps, pile caps, backwalls, retaining walls, and cheek walls.
   j. Approach slabs.
   k. Concrete aprons between new abutment caps and existing stone masonry abutments.
   l. Concrete wingwalls.
   m. Fence Post Foundations.
2. Drilling and grouting reinforcing steel dowels.
3. Repair of existing foundations with grout bags.

B. Related Work: The following items are not included in this Section and shall be performed under the designated Sections:

1. Section 02260 – EXCAVATION SUPPORT AND PROTECTION
2. Section 02300 – EARTHWORK
3. Section 02370 – DRILLED SHAFTS
4. Section 03410 – PLANT-PRECAST STRUCTURAL CONCRETE
5. Section 03930 – CONCRETE REHABILITATION
6. Section 05100 - STRUCTURAL STEEL
7. Section 05500 - MISCELLANEOUS METALS
8. Division 16 - ELECTRICAL

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.
2. Indicate amount of fly ash in the mix.

C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

1. Indicate coordination requirements for reinforcement locations with requirements of structural steel, steel joints and steel deck.

D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer licensed in the Commonwealth of Massachusetts detailing fabrication, assembly, and support of formwork.

1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing reshoring.
2. Blockouts for Architectural Joint Systems: Indicate blockouts and coordination with architectural joint systems.

E. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates.

F. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Fiber reinforcement.
6. Waterstops.
7. Curing compounds.
8. Floor and slab treatments.
9. Bonding agents.
10. Adhesives.
11. Vapor retarders.
12. Semirigid joint filler.
13. Joint-filler strips.
14. Repair materials.

G. Floor surface flatness and levelness measurements to determine compliance with specified tolerances and requirements for applied finishes and materials, except as noted for slope to drains.

H. Field quality-control test and inspection reports.

I. Minutes of preinstallation conference.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

B. Testing and Inspection Services by the Authority: Sampling and testing of concrete ingredients; design or acceptance of concrete mix proportions; concrete plant inspection; and field control will be by the Engineer at the expense of the Authority.

1. The Contractor agrees to accept as indicative, the results of tests, including test results involving mix designs and field quality control of concrete mixtures. If, as a result of these tests, it is determined that the specified concrete properties are not being obtained, the Engineer may order such changes in proportions or materials, or both, as may be necessary to secure the specified properties, at no additional expense to the Authority.
2. The use of testing and inspection services shall in no way relieve the Contractor of his responsibility to furnish materials and construction in compliance with the Contract Documents.
3. Failure to detect any defective work or material shall not in any way prevent later rejection when such defect is discovered, nor shall it obligate the Engineer for final acceptance.
4. Additional testing and inspection services requested by the Contractor because of changes in materials, sources, or proportions, or occasioned by failure of tests and inspection to meet specification requirements, shall be paid for by the Contractor. The costs for such additional testing and inspection services will be established by the Engineer.
    a. Provide at no additional expense to the Authority all materials, labor, and services for sampling and testing required by the Engineer, including but not limited to:
    b. Transportation of sample materials from source to the Authority's Materials Testing Laboratory, 170 Freeport Street, Dorchester, Massachusetts.
    c. Preparation, handling, storage and transportation of concrete test specimens as directed by the Engineer.
    d. Suitable containers for the storage, curing and transportation of concrete test specimens in accordance with ASTM C 31.
    e. Suitable storage for a supply of test cylinder molds, test equipment and other items required for sampling and testing.

C. When additional sets of test cylinders beyond the mandatory seven and twenty-eight day tests are required by the Contractor to verify early form removal or other reasons for his benefit, the Authority shall be reimbursed for the cost of fabricating and testing these additional test cylinders. The Contractor has the option of obtaining additional test services from an independent testing laboratory agency approved by the Engineer. Copies of test data from these additional tests shall be submitted to the Engineer for review and approval.

D. The minimum number of test cylinders to be made for each class of concrete and for each placement shall be four for each 100 cubic yards or less and minimum of four extra cylinders for each additional 50 cubic yards or fraction thereof. When additional sets of test cylinders are required beyond the normal seven and twenty-eight day tests, each set shall consist of a minimum of two test cylinders.

E. Independent Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

F. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.

G. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel".

H. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specification for Structural Concrete".
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials".

I. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

J. Preinstallation Conference: Conduct conference at Project site to address the following:

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
   a. Contractor's superintendent.
   b. Independent testing agency responsible for concrete design mixtures.
   c. Ready-mix concrete manufacturer.
   d. Concrete subcontractor.

2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Cement: Shall be American-made Portland Cement, free from water soluble salts or alkalis which will cause efflorescence on exposed surfaces. Portland Cement shall be Type II, ASTM C 150. Use only one brand of cement for each type of cement throughout project. Contractor shall be responsible for whatever steps are necessary to insure that no visual variations in color will result in exposed concrete and shall place on order and secure in advance a sufficient quantity of this (these) cement(s) to complete concrete work specified herein.

1. Fly Ash: ASTM C 618, Type F 15-35%
2. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120, 25-50%

B. Normal Weight Fine Aggregate: Shall be washed, inert, natural sand conforming to ASTM C 33 and following additional requirements:

Sieve	Percent Passing
#4	– 95-100 (typical)
#16	– 50-85
#50	– 5-30
#100	9– 0-10
Fineness Modulus	2.80 (Plus/Minus 0.20)
Organic	Plate 2 maximum
Silt	2.0 percent maximum
Mortar Strength	100 percent minimum compression ratio
Soundness	15 percent maximum loss, magnesium sulfate, five cycles

C. Normal Weight Coarse Aggregate: Shall be well graded crushed stone or washed gravel conforming to ASTM C 33 and the following additional requirements:

Designated Size (inches)	3	2	1-1/2	1	3/4	1/2	3/8
F.M. (+/-0.20)	7.95	7.45	7.20	6.95	6.70	6.10	4.50

Organic	Plate 1 maximum
Silt	1.0 percent maximum
Soundness	5 percent maximum loss, magnesium sulfate, five cycles

D. Maximum designated sizes for normal weight coarse aggregate to be used in concrete sections shall be as noted below, except that sizes shall also be chosen in conjunction with required clearances.

1. One and one-half inches for sections over ten inches in thickness.
2. One inch for sections more than eight and up to ten inches in thickness.
3. Three-quarter inch for sections more than three and up to eight inches in thickness.

E. Concrete Fill for Steel Stair and Landing Pans: Composed of 1:2:2 mix with three-eighths inch maximum size normal weight aggregate and shall be placed with a 0 inches to 1 inch slump.

F. Water: From approved source, potable, clean and free from oils, acids, alkali, organic matter and other deleterious material and complying with the requirements of ASTM C 94.

G. Admixtures:

1. Water-reducing agent:
   a. "WRDA" - W.R. Grace & Co.
   b. "PDA25" - Protex Industries, Inc.
   c. "Pozzolith 344H" - Master Builder's Co.
   d. Note: Water-reducing agent shall be by same manufacturer as air-entraining agent.

2. Air-entraining agent:
   a. "DAREX AEA" - W.R. Grace & Co.
   b. "PROTEX AEA" - Protex Industries
   c. "MB-VR" or "MB-AE" - Master Builder's Co.

3. Superplasticizer: High-range water-reducer conforming to ASTM C 494, Type F or Type G.
4. Admixtures retarding setting of cement in concrete shall not be used without written approval of Engineer.
5. Admixtures causing accelerated setting of cement in concrete shall not be used without written approval of Engineer.

2.2 CONCRETE MIXTURES

A. The Contractor shall recommend, on the basis of trial mixes and strength curves specified below, design mixes for each type and strength of concrete. The Testing Agency shall verify that the proposed mix designs conform to all specification requirements.

B. Sufficient materials for concrete mix design shall be furnished by Contractor not less than five weeks before use. Duplicate small samples plainly and neatly labeled with source, where proposed to be used, date, and name of collector shall be provided and presented to Testing Agency for permanent reference.

C. Mixes shall be designed in accordance with "Method 1" of ACI 301, and the requirements of this Section. All concrete is normal weight unless specifically designated otherwise; air-dry weight not to exceed 150 lbs. per cubic foot.

D. All structural concrete shall have a minimum 28 day compressive strength of 4,000 psi.

E. Exterior concrete shall contain air-entraining admixture when tested to ASTM C 231 at the point of discharge from the truck mixer:

Aggregate Size	Air Content, %
1-1/2 in.	4.5 - 7.5
3/4 in.	5.0 - 8.0
3/8 in.	6.0 – 9.0

F. Concrete shall have the following slump when tested to ASTM C 143 at the point of discharge from the truck mixer:

Condition	Slump, inches
With Water-Reducing Agent	4-1/2 - 7
Without Water-Reducing Agent	2 - 5

G. Concrete slabs, including slabs on grade, shall have a mid-range water reducer and have a maximum slump of 6 inches.

H. The approved superplasticizer shall be used in all concrete walls, including slabs on grade.

I. Design mix of concrete to be used in work shall correspond to following test strengths (TABLE A) obtained in laboratory trial mixtures.

TABLE A

Minimum Strength of Lab Trial Mixes (psi)

Design Strength	Trial Mix Strength 7-days	28-days
4000	3400	5200
5000	4200	6200

J. Any deviation from approved mix design, which Contractor deems desirable under certain project conditions, will not be allowed without written approval of Engineer. Cost of any additional testing by Testing Agency associated therewith shall be paid for by Contractor.

2.3 FORM MATERIALS

A. Construct formwork to shapes, lines, and dimensions required, plumb and straight, secured and braced sufficiently rigid to prevent deformation under load, and sufficiently tight to prevent leakage, all in conformance with ACI Standard 347, "Recommended Practice for Concrete Formwork".

B. Formwork for exposed concrete shall be medium-density plastic overlaid plywood, 5/8" mini-mum thickness; for concealed concrete shall be "Plyform" plywood, 5/8" minimum thickness.

C. Chamfer Strips: Half-inch, 45 degree poplar wood strips, nailed six inches on center, and installed in inside corners of all forms, unless otherwise directed by Engineer.

D. Form Ties and Spreaders: Richmond Tyscrus by Richmond Screw Anchor Co.; Superior-ties by Superior Concrete Accessories, Ind.; or Sure-Grip Ties by Dayton Sure-Grip and Shore Co. Wire ties shall not be used. Ties for foundation walls shall be snap-ties or type specified above with removal cones and shall incorporate water seal washer. Ties shall be arranged in a symmetrical manner.

E. Form Release Agent: Non-staining and non-emulsifiable type, or equal approved by Engineer. Form release agent shall be biodegradable and shall not impart any stain to concrete nor interfere with adherence of any material to be applied to concrete surfaces.

2.4 REINFORCEMENT AND ACCESSORIES

A. Reinforcing Steel Bars: Shall be newly rolled billet steel conforming to ASTM A 615 Grade 60. Bars shall be bent cold.

B. Welded Wire Fabric: Shall conform to ASTM A 185.

C. All structural steel reinforcement and embedded items shall be epoxy coated in accordance with ASTM A 775.

D. Reinforcement Accessories: Shall conform to Product Standard PS7-766, National Bureau of Standards, Department of Commerce, Class C, as produced by Superior Concrete Accessories, Inc.; Dayton Sure-Grip Co.; or R.K.L. Building Specialties Co., Inc. Reinforcement accessories shall include spacers, chairs, ties, slab bolsters, clips, chair bars, and other devices for properly assembling, placing, spacing, supporting, and fastening reinforcement. All reinforcement accessories shall be epoxy coated. Tie wire shall be epoxy coated wire of sufficient strength for intended purpose, but not less than No. 18 gage. Metal supports shall be of such type as not to penetrate surface of formwork and show through surface of concrete. Accessories touching interior formed surfaces exposed to view shall have not less than 1/8 inch of plastic between metal and concrete surface. Plastic tips shall extend not less than 1/2 inch up on metal legs. Individual and continuous slab bolsters and chairs shall be of type to suit various conditions encountered and must be capable of supporting 300 pound load without damage or permanent distortion.

2.5 MISCELLANEOUS MATERIALS

A. Grout: Ready-to-use aggregate product requiring only addition of water at job site such as "Embeco Pre-mixed Grout" by Master Builder's; "Vibro-Foil Ready-Mixed" by W.R. Grace & Co.; or "Ferrolith G" by Sonneborn Building Products, Inc. Grout shall be easily workable and shall have no drying shrinkage at any age. Compressive strength of grout (2" x 2" cubes) shall not be less than 5000 psi at 7 days, and 7500 psi at 28 days.

B. Waterstops: Extruded virgin PVC containing no scrap or reclaimed material or pigment. Provide cross section as indicated, uniform along the length of the waterstop and symmetrical transversely so that the thickness at any given distance from either edge of the waterstop shall be uniform. The finished waterstop shall meet the requirements specified below for the average of five samples tested in each case. Report standard deviations of values in addition to averages. Condition and test samples in atmosphere of 73 (plus or minus 3) degrees F and 50 (plus or minus 10) percent relative humidity, except where other test conditions are specified.

1. Tensile strength, per ASTM D 638. Die IV-: 2000 psi. minimum.
2. Ultimate elongation, per ASTM D 638. Die IV: 350 percent, minimum.
3. Tear resistance, per ASTM D 624. Die B: 350 pounds per inch of thickness, minimum
4. Stiffness in flexure, samples reduced to 1/8-inch thickness, per ASTM D 747. 1/4 inch span: 600 psi. minimum.

5. Low temperature brittleness samples reduced to 1/8-inch thickness, per ASTM D 746: no cracking, chipping, or sign of failure at minus 35 degrees F.
6. Accelerated Extraction, samples reduced to 1/8-inch thickness, per Corps of Engineers CRDC-572: tensile strength, per ASTM D 412. Die C 1750 psi. minimum; ultimate elongation, per ASTM D 412. Die C: 300 percent, minimum.
7. Effect of Alkali, samples reduced to 1/8-inch thickness, per Corps of Engineers CRDC-572: Change in weight. 7 days: minus 0.10 to plus 0.25 percent; Change in weight. 30 days minus 0.10 to plus 0 25 percent; Change in hardness. 7 days. per ASTM D 2240. Shore A-2: plus or minus 5 points; Change in thickness. 30 days: plus or minus 1.0 percent.
8. Tensile strength of samples taken across site-made and factory-made splices, per ASTM D 638 Die I \1000 psi. minimum

C. Vapor Barrier: 6 mil polyethylene, unless specifically specified elsewhere.

D. Membrane Curing Compound: ASTM C 309, Type 1. Product used shall be shown to be compatible with the later application of coatings. Curing compound shall not be used on any floor slab scheduled to receive an adhered floor finish.

E. Membrane Curing Compound for Architectural Concrete: Liquid membrane curing compound complying with AASHTO M148, Type 1D, except Type 2 if required to control temperature of mass concrete and hot weather concrete.

F. Sheet Curing Materials: Waterproof paper (regular or white), polyethylene film (clear or opaque white), and white burlap-polyethylene sheet complying with AASHTO M171.

G. Chemical Hardener: All exposed concrete floor slabs shall be hardened with three applications of fluosilicate chemical hardener followed by two applications of clear acrylic concrete sealer by Sonneborn Division, ChemRex Inc. "Lapidolith"; or equal products by W.R. Meadows Co. and Concrete Service Material Company or other manufacturers.

H. Penetrating Sealer: Monomeric alkyalkoxy silane sealer which has demonstrated penetrability into dry low permeability concrete to a minimum of 1/4 inch. Sealer shall have 20 to 25 percent solids when used on walls, and 40 to 50 percent solids when used on floors.

I. Epoxy Membrane Curing Compound/Concrete Sealer: The two component, epoxy resin system shall act as a dual purpose material: A membrane compound for curing alone, plus a penetrating sealer. It shall provide protection for concrete exposed to de-icing salts, commercial acids and alkalis, gasoline, diesel fuel, and oil, and exposure to freeze/thaw cycles and to vehicular traffic. The epoxy resin compound shall be furnished in two components for combining immediately prior to use in accordance with the manufacturer's written instructions as specified herein. The components of the epoxy resin system shall conform to the following requirements.

1. Component A: Poly (2 hydroxypropylene, P'p, isopropylidenephenolate) condensed with 1 chlorepropoxirane such that the ox content is 4% in aralkyl and hydroxylated solvents. Component B: The amido amine condensate of the Diels Alder adduct of polyunsaturated acids dissolved in suitable solvents. Ratio of components (A to B): 1:1 by volume.
2. Properties of Mixed Material:
   a. Viscosity: 75 to 125 cP's at 75°F.
   b. Pot Life: 8 hours minimum at 75°F.
   c. Minimum Solids Content: 40 to 44% by weight.
   d. Recoat Time: 24 hours maximum.
   e. Dry Film Thickness: 2 to 3 mils per coat.

f. Color: Clear, White tint, gray tint.

3. Properties of Cured Material:
   a. The cured system shall exhibit no evidence of a mine blushing or sweating which may inhibit bond of subsequent coats.
   b. When tested according to ASTM D 968, specimens of coating cured for 14 days at 75°F shall exhibit an abrasion coefficient of at least 30 liters per mil.
   c. When tested according to ASTM D 522, a 2 mil dry film thickness specimen cured for 14 days at 75° shall exceed 12% elongation when tested on the 1/4 inch mandrel.
   d. Specimens cured for 14 days at 75°F and immersed for 48 hours shall exhibit less than 1% water absorption by weight.
   e. Water Retentivity shall not exceed 0.055 grams per square centimeter when tested according to ASTM C 156.

J. Grout Bags: **(BEING DEVELOPED)**

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine all work prepared by others to receive work of this Section. Commencement of work will be construed as complete acceptance of preparatory work by others.

1. Hold Point-A pre-placement inspection shall be performed by the Contractor prior to placing concrete to assure that placement prerequisites have been accomplished.

3.2 HANDLING, STORAGE, AND PROTECTION OF MATERIALS

A. Handle and store materials separately in such manner as to prevent intrusion of foreign matter, segregation, or deterioration. Do not use foreign materials or those containing ice. Remove improper and rejected materials immediately from point of use. Cover materials, including steel reinforcement and accessories, during construction period. Stockpile concrete constituents properly to assure uniformity throughout project.

3.3 ERECTION OF FORMWORK, SHORING AND RESHORING

A. Set and maintain formwork to insure complete concrete work within tolerance limits listed in ACI 347 latest edition, "Recommended Practice for Concrete Formwork", and with following additional requirements:

1. Maximum variations from plumb:
   a. In surfaces of columns and walls:

      1) In any 10 feet of length: 1/4 inch
      2) Maximum for entire length: 1/2 inch

2. Maximum variations from established position in plan shown on the drawings:
   a. Column: 1/2 inch
   b. Walls: 3/4 inch

3. Variations in cross-sectional dimensions of columns and beams and in thickness of slabs and walls.
   a. Minus: 1/8 inch
   b. Plus: 1/4 inch

B. Before form materials can be re-used, surfaces that will be in contact with freshly cast concrete shall be thoroughly cleaned, damaged areas repaired and projecting nails withdrawn. Re-use of form material shall be subject to approval by Engineer.

3.4 PLACING OF REINFORCEMENT

A. Reinforcement shall be placed in accordance with requirements of CRSI 93, "Recommended Practice for Placing Reinforcing Bars" and CRSI 93, "Recommended Practice for Placing Bar Supports" and with further requirements below.

B. Reinforcement shall be accurately placed in accordance with Contract Documents and shall be firmly secured in position by wire ties, chairs, spacers, and hangers, each of type approved by Engineer.

C. Bending, welding or cutting reinforcement in field in any manner other than as shown on Drawings, is prohibited, unless specific approval for each case is given by Engineer.

D. Reinforcement shall be continuous through construction joints unless otherwise indicated on Drawings.

E. Reinforcement shall be spliced only in accordance with requirements of Contract Documents or as otherwise specifically approved by Engineer. Splices of reinforcement at points of maximum stress shall generally be avoided. Welded wire fabric shall lap six inches or one space plus two inches whichever is larger, and shall be wired together.

F. At time concrete is placed, reinforcement shall be free of excessive rust, scale, or other coatings that will destroy or reduce bond requirements. Reinforcement expected to be exposed to weather for a considerable length of time shall be painted with a heavy coat of cement grout. Protect stored materials so as not to bend or distort bars in any way. Bars that become damaged will be rejected.

G. Hold Point - Before concrete is cast, check all reinforcement after it is placed to insure that reinforcement conforms to Contract Documents and approved Shop Drawings. The Engineer shall be notified at least 36 hours prior to concrete placement and given opportunity to inspect completed reinforcement and formwork before concrete placement. Prior approval of Shop Drawings shall in no way limit Engineer's right to demand modifications or additions to reinforcement or accessories.

3.5 DRILLING AND GROUTING REINFORCING STEEL

A. (BEING DEVELOPED)

3.6 JOINTS

A. Construction and control joints indicated on Drawings are mandatory and shall not be omitted.

B. Joints not indicated or specified shall be placed to least impair strength of structure and shall be subject to approval of Engineer.

C. Waterstops:

1. Protect waterstop from oil, dirt, concrete spatter, and damage, and leave clean to receive concrete forms. Exercise care during installation of waterstop to eliminate all possibilities that may cause leakage. Ensure reinforcing bars and slip dowels will not interfere with positioning of waterstop during Installation.
2. Install waterstops in accordance with manufacturer's recommendations and as indicated. Hold waterstops rigidly in place by extending through slots in keyways, by spilt bulkheads, by trying to reinforcing bars, or by such other adequate methods as are necessary to insure proper support and embedment during the concreting process. Secure waterstop between the last rib and the end of the waterstop when tying to reinforcing rods. Tie waterstop to reinforcing bars every 12 inches.
3. Install waterstop so that half of the ribs of the waterstop material are embedded in the concrete on each side of the joint. When installed in an expansion joint, exercise care in pouring so that the closed hollow center-bulb remains in the gap between the first and second pour, to allow for maximum elongation with minimum stress on the portion of the waterstop embedded in the concrete.
4. Install expansion joint material and a sealant in the joint, as indicated, to prevent foreign matter from accumulating in the joint area. When a sealant is used place a separator between the sealant and the waterstop to insure that both the waterstop and sealant best perform their respective functions.
5. Sweep horizontal joints prior to pour to insure that foreign matter does not interfere with direct contact between the waterstop and concrete.
6. Systematically and thoroughly vibrate concrete around waterstop to avoid honeycombs and voids in the concrete and to insure complete contact of waterstop to concrete.
7. For the second pour on horizontal sections, make a grout pour over the waterstop to prevent excessive movement of the waterstop and to provide positive insurance against honeycombing or voids. Use a thicker waterstop. 3/8 inch or 1/2 inch. for heavy pour or larger aggregate.
8. Where using split-ribbed waterstop spread open the split leg of the waterstop and nail it to the bulkhead between the last two ribs. Upon completion of the first pour and removal of the bulkhead, join the split leg together every 12 inches with hog rings and position it for the second pour.
9. PVC waterstop may be butt-spliced on the job with an electrical splicing iron or a hot air welding gun and vinyl welding rod in accordance with the manufacturer's instructions.
10. Do not drive nails through center of waterstop. Do not lap waterstop, splice joints. Do not embed center bulb in concrete. Position it in the center of the joint to insure freedom of movement. Do not secure waterstop except between the last rib and the end of the waterstop when tying to the reinforcing rod to hold in place for the pour. Where using split-ribbed waterstop, do not nail split legs to bulkhead adjacent to bulb.

3.7 INSTALLATION OF EMBEDDED ITEMS

A. Conform to requirements of ACI 318, paragraph 6.3, "Conduits and Pipes Embedded in Concrete", and as specified below.

B. Install steel sleeves, embedded wall plates and similar items, furnished by other trades, at locations shown on the drawings.

C. Anchor bolts for column baseplates shall be installed with templates provided. Vertical alignment and plan locations shall be maintained within one-sixteenth inches of the locations shown on the drawings.

1. Inspection shall be performed by a surveyor licensed in the Commonwealth of Massachusetts. Certify compliance with shop drawings.

3.8 MIXING, CONSISTENCY, AND DELIVERY OF CONCRETE

A. Concrete shall be ready-mixed, produced by plant acceptable to Engineer. Hand or site mixing shall not be done. Constituents, including admixtures except certain corrosion inhibitors and superplasticizers, shall be batched at central batch plant. Admixtures shall be premixed in solution form and dispensed as recommended by manufacturer.

B. Central plant and rolling stock equipment and methods shall conform with Truck Mixer and Agitator Standard of Truck Mixer Manufacturer's Bureau of National Ready-Mixed Concrete Association, and Contract Documents. Consistency of concrete at time of deposit shall be as follows:

Portion of Structure	Slump Recommended	Max. Range
Walls, columns	4"	3" - 5"
Slabs, beams	3"	2" - 4"

C. Ready mixed concrete shall be transported to site in watertight agitator or mixer trucks loaded not in excess of rated capacities. Discharge at site shall be within one and one-half hours after cement was first introduced into mix. Discard concrete not discharged within one and one-half hours and dispose of legally. Concrete with a temperature greater than 85 degrees F. shall not be placed. Central mixed concrete shall be plant mixed a minimum of five minutes. Agitation shall begin immediately after premixed concrete is placed in truck and shall continue without interruption until discharged. Transit mixed concrete shall be mixed at mixing speed for at least ten minutes immediately after charging truck followed by agitation without interruption until discharged. Concrete shall be furnished by a single plant unless accepted by the Engineer in writing.

D. Retempering of concrete which has partially hardened, that is, mixing with or without additional cement, aggregates, or water, will not be permitted.

3.9 PLACING CONCRETE

A. Remove water and foreign matter from forms and excavations and, except in freezing weather or as otherwise directed, thoroughly wet wood forms just prior to placing concrete. Place no concrete on frozen soil and provide adequate protection against frost action during freezing weather.

B. To secure full bond at construction joints, surfaces of concrete already placed, including vertical and inclined surfaces, shall be thoroughly cleaned of foreign materials and laitance,

roughened with suitable tools such as chipping hammers or wire brushes, and recleaned by stream of water or compressed air. Well before new concrete is deposited, joints shall be saturated with water. After free or glistening water disappears joints shall be given thorough coating of neat cement slurry mixed to consistency of very heavy paste. Surface shall receive coating of approximately one-eighth inch thick; this shall be scrubbed in by means of stiff bristle brushes. New concrete shall be deposited before neat cement dries or changes color.

C. Do not place concrete having slump outside of allowable slump range.

D. Transport concrete from mixer to place of final deposit as rapidly as practical by methods which prevent separation of ingredients and displacement of reinforcement, and which avoid rehandling. Deposit no partially hardened concrete. When concrete is conveyed by chutes, equipment shall be of such size and U-shaped design as to insure continuous flow in chute. Flat (coal) chutes shall not be employed. Chutes shall be of metal or metal lines and different portions shall have approximately same slope. Slope shall not be less than 25 degrees nor more than 45 degrees from horizontal and shall be such as to prevent segregation of ingredients. Discharge end of chute shall be provided with baffle plate or spout to prevent segregation. If discharge end of chute is more than five feet above surface of concrete in forms, spout shall be used, and lower and maintained as near surface of deposit as practicable. When operation is intermittent, chute shall discharge into hopper. Chute shall be thoroughly cleaned before and after each run and debris and any water used shall be discharged outside forms. Concrete shall not be allowed to flow horizontally over distances exceeding five feet.

E. Concrete shall be placed in such manner as to prevent segregation, and accumulations of hardened concrete on forms or reinforcement above mass of concrete being placed. To achieve this end, suitable hoppers, spouts with restricted outlets and tremies shall be used as required.

F. During and immediately after depositing, concrete shall be thoroughly compacted by means of internal type mechanical vibrators or other tools, or by spading to produce required quality of finish. Vibration shall be done by experienced operators under close supervision and shall be carried on only enough to produce homogeneity and optimum consolidation without permitting segregation of constituents or "pumping" of air. Vibrators used for normal weight concrete shall operate at speed at not less than 7,000 vpm and be of suitable capacity. Do not use vibrators to move concrete. Vibration shall be supplemented by proper wooden spade puddling to remove included bubbles and honeycomb adjacent to visible surfaces. At least one vibrator shall be on hand for every 10 cubic yards of concrete placed per hour, plus one spare. Vibrators shall be operable and on site prior to starting placement.

G. Vertical lifts shall not exceed 18 inches. Vibrate completely through successive lifts to avoid pour lines. Vibrate first lift thoroughly until top of lift glistens to avoid stone pockets, honeycomb, and segregation.

H. Concrete shall be deposited continuously, and in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause formation of seams and planes of weakness within section. If section cannot be placed continuously between planned construction joints, as specified, field joint and additional reinforcement shall be introduced so as to preserve structural continuity. Engineer shall be notified in any such case.

I. Cold joints, particularly in exposed concrete, including "honeycomb", are unacceptable. If they occur in concrete surfaces exposed to view, Engineer will require that entire section in which blemish occurs be removed and replaced with new materials at Contractor's expense.

J. When placing exposed concrete walls or columns, strike corners of forms rapidly and repeatedly from outside along full height while depositing concrete and vibrating.

K. Chutes, hoppers, spouts, adjacent work, etc. shall be thoroughly cleaned before and after each run and water and debris shall be discharged outside form.

3.10 FINISHING OF UNFORMED CONCRETE SURFACES

A. Smooth troweled finish: Shall be provided where concrete flatwork is to be exposed in the finished work or is to receive resilient flooring materials.

B. Floated finish: Shall be provided where concrete flatwork is to receive waterproofing membranes or setting beds for finished materials.

C. Floated finish: Shall be provided for top surfaces of walls, slabs and beams.

D. Rough struck surface shall be provided at top of pedestals.

E. Steel Broom Finish (with smooth edging): Shall be provided at exterior concrete walks, pavements and steps.

F. Contractor, at his own expense, shall level depressed spots and grind high spots in concrete surfaces which are in excess of specified tolerances. Leveling materials proposed for providing proper surface shall be approved by Engineer.

3.11 REPAIRING OF UNFORMED CONCRETE SURFACES

A. Tops of slabs and walls shall be repaired by using either same material as originally cast or by use of dry-pack material, as approved by Engineer. Areas affected shall be chipped back square and to depth of one inch minimum. Hole shall then be moistened with water for a minimum of two hours, followed by brush coat of 1/16 inch thick cement paste. Immediately plug hole with concrete, or with dry pack material consisting of 1:1.5 mixture of cement and concrete sand mixed slightly damp to touch. Hammer dry-pack into hole until dense, and excess paste appears on surface. Finish patch flush and to same texture as surrounding concrete. For large repairs employ 1-1-2 mixture of cement, concrete sand and pea gravel at same dry-pack consistency.

3.12 CURING, SEALING AND PROTECTION

A. When concrete is placed at or below ambient air temperatures of 40 degrees F. or whenever in opinion of Engineer, such or lower temperatures are likely to occur within 48 hours after placement of concrete, cold weather concreting procedures, according to ACI 306 and as specified herein, shall be followed. To this end, entire area affected shall be protected by adequate housing or covering, and heating. No salt, chemicals or other foreign materials shall be used in the mix to lower freezing point of concrete.

B. Protect concrete work against injury from heat, cold, and defacement of any nature during construction operations.

C. Concrete shall be treated and protected immediately after concreting or cement finishing is completed, to provide continuous moist curing above 50 degrees F. for at least seven days, regardless of ambient air temperatures.

D. Curing compounds will not be permitted for slab and beams.

E. Keep a permanent temperature record showing date and outside temperature for concreting operations. Thermometer readings shall be taken at start of work in morning, at noon, and again late in afternoon. Locations of concrete placed during such periods shall likewise be recorded, in such manner as to show any effect temperatures may have had on construction. Copies of temperature record shall be distributed daily to Engineer.

F. Epoxy Curing Compounds/Hardener:

1. Apply the first coat of epoxy to the plastic concrete as soon as the bleed water has totally disappeared. This application shall serve a dual function: a membrane curing compound which shall retain 95% or more of the mixing water in the concrete for a minimum of seven days; and the first coat of a two-coat system to seal and protect the concrete.
2. After a minimum curing period of 30 days and before the structure is opened to general use, wash the concrete with cleaning and degreasing chemical solution applied in accordance with the manufacturer's instructions and as specified herein.
3. Prepare the cleaning solution in accordance with the manufacturer's instructions. Dampen concrete surface with water. Apply the prepared solution over the area to be cleaned using a soft fibered but densely filled brush. Allow the solution to remain on the surface for 3 to 5 minutes. Reapply the cleaning solution and scrub vigorously. Rinse with fresh water applied at a pressure of 400-800 psi and a volume of water per minute 5 - 10 gallons. Protect all non-masonry surfaces.
4. Allow concrete to dry a minimum of 24 hours and a maximum of 48 hours before application of the second coat of epoxy.
5. Pour equal quantities of Components 'A' and 'B' into a clean container. Mix thoroughly with a low speed electric drill equipped with a steel paddle. Keep individual components and mixed compound covered when material is not being used.
6. Application: Apply mixed epoxy compound in a uniform coat at the rate of approximately 200 sq. ft. per gallon. Mixed material may be sprayed with any equipment capable of spraying epoxy compounds, or it may be applied with a deep nap lamb's wool roller.
7. Protect surface against vehicular and pedestrian traffic during curing period (24 hours at 75°F).
8. Final Coat - Broom Finish and Wood Float Finish: Concrete is totally sealed against contaminants and resists the attack of de-icing chemicals. It may be applied at any time after the concrete has cured a minimum of 30 days and before the structure is opened to general use. Apply the epoxy compound by spray or roller at the rate of 275 to 325 sq. ft. per gallon being careful to avoid puddles or uneven application. The concrete shall exhibit a uniform gloss indicating it is totally sealed. Any areas that are dull or flat are not totally sealed. Any areas that are dull or flat are not totally sealed and shall be given a third coat.
9. Final Coat - Steel Trowel Finish Concrete: Apply the second and final coat at any time after the concrete has cured a minimum of 30 days and before the structure is opened to general use. Apply mixed epoxy compound in a uniform coat at a rate not to exceed 200 sq. ft. per gallon. While the epoxy compound is still liquid, drop fine sand meeting the gradation requirements of ASTM C-109, vertically into the epoxy at a uniform rate of one lb. per sq. ft. Make sure entire

epoxy surface is thoroughly covered. After epoxy has hardened so that it cannot be dented with a screwdriver, remove excess sand.

G. Concrete Sealer: Apply to bridge copings, beam sets, parapets, vehicle barriers, boatwalls portal flank walls and other concrete surfaces indicated. Apply in accordance with manufacturer's instructions and the following:

1. Application of the sealer shall not alter the surface texture and shall be compatible with the use of surface finish coatings and caulkings. Surface shall dry to a tack-free condition in 4 hours or less.
2. Preparation process shall not cause any undue damage to the concrete surface, remove or alter the existing surface finish, or expose the coarse aggregate of the concrete.
3. Concrete sealer shall be used as supplied by the manufacturer and not altered in any way. Apply onto concrete surfaces at manufacturer's recommended rate of coverage.
4. Prevent the concrete sealer from coming in contact with open joints that have not yet been filled with joint sealant, so as to prevent any loss of bond of the joint sealant.

3.13 REMOVAL OF FORMWORK, SHORING AND RESHORING

A. Contractor shall be responsible for proper removal of formwork, shoring, and reshoring.

B. Forms shall be removed only after concrete has attained sufficient strength to support its own weight, construction loads to be placed thereon and lateral loads, without damage to structure or excessive deflection.

C. Forms and falsework shall not be removed unless the concrete has attained the minimum percentage compressive strength as listed in the following table:

Structural Member	Minimum Percent of Design Strength (f'c)
1. Invert Slabs; Slabs and Beams on Grade	25
2. Free Standing Walls, Columns and Piers	40
3. Retaining Walls	50
4. Soffits of Beams, Slabs and Girders Less Than 20 Foot Span	80
5. Stairs	80
6. Soffits of Beams, Slabs and Girders Greater Than 20 Foot Span	90
7. Cantilevered Beams, Slabs and Girders	90

D. Acceptance for form removal will be based on field-cured concrete cylinders tested by the MBTA Lab.

3.14 REPAIRING AND FINISHING OF FORMED AND ARCHITECTURAL CONCRETE SURFACES

A. In accordance with the provisions of ACI 301, Chapter 10, all concrete shall have "smooth form finish".

B. Intent of this Specification is to require forms, mixtures of concrete, and workmanship so that concrete surfaces will require no patching, except for plugging of tie holes. However, where patching is acceptable to Engineer, procedure described below shall be followed.

C. Defective concrete and honeycombed areas shall not be patched unless examined and approval is given by Engineer. If such approval is received by Contractor, areas involved shall be chipped down square and at least one inch deep to sound concrete by means of cold chisels or pneumatic chipping hammers. If honeycomb exists around reinforcement, chip to provide clear space at least three-quarter inch wide all around steel to afford proper ultimate bond thereto. For areas less than one and one-half inches deep, patch shall be made in same manner as described above for filling unformed concrete surfaces, care being exercised to use crumbly-dry (nontrowelable) mixtures and to avoid sagging. Thicker repairs shall require build-up in successive days, each layer being applied as described. To aid strength and bonding of multiple layer repairs, non-shrink, non-metallic aggregate shall be used as an additive as follows:

Materials	Volumes	Weights
Cement	1.0	1.0
Non-Metallic Aggregate	0.15	0.25
Sand	1.5	1.55

1. For very heavy (generally, formed) patches, pea gravel may be added to mixture and proportions modified as follows:

Materials	Volumes	Weights
Cement	1.0	1.0
Non-Metallic Aggregate	0.2	0.33
Sand	1.0	1.0
Pea Gravel	1.5	1.55

D. After hardening, rub lightly as described above for form tie holes.

1. Mortar for patching shall be same mix as above except aggregate shall pass a No. 14 sieve.
2. For all concrete to receive "smooth" finish, remove formwork fins and clean entire surface of grease, form oil, laitance, dust, and other foreign matter.
3. "Smooth" finish shall consist of having all fins removed, joint marks smoothed off, blemishes removed, and surfaces left smooth and unmarred.
4. Begin finishing operations as soon as practicable after removal of forms, continue with curing operations after finishing is completed. After concrete has been well cured, carefully inspect surfaces. Remove any fins, rough spots, streaks, hardened mortar or grout and other foreign material. Patch defects with finishing mortar as specified above, to satisfaction of Engineer.

E. Patches which become crazed, cracked, or sound hollow upon tapping shall be removed and re-placed with new material at Contractor's expense.

3.15 CLEANING

A. Concrete surfaces shall be cleaned of objectionable stains as determined by the Engineer. Materials containing acid in any form or methods which will damage "skin" of concrete surfaces shall not be employed, except where otherwise specified.

3.16 REPAIRING EXISTING FOUNDATIONS WITH GROUT BAGS

A. **(BEING DEVELOPED)**

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Cast-In-Place Concrete for bridge abutment caps, back walls, wing walls, abutment aprons and approach slabs, will be measured by the cubic yard, complete in place, under Item No. 0330.073 - 4000 psi ¾" Aggregate Concrete, and shall include all concrete cement, formwork, coring, reinforcement, construction joints, expansion joints, and furnishing all labor, equipment, materials, accessories and incidentals to complete work to the satisfaction of the Engineer.

B. Cast-In-Place Concrete for spandrel wall and pier extension at Baker's Brook Bridge (MP 47.84) will be measured by the cubic yard, complete in place, under Item No. 0330.074 - 4000 psi 1½" Aggregate Concrete, and shall include all concrete cement, formwork, reinforcement, construction joints, joints, and furnishing all labor, equipment, materials, accessories and incidentals to complete work to the satisfaction of the Engineer.

C. Drilling and grouting reinforcing steel dowels into existing structure to remain will be measured by the linear foot, complete in place under Item 0321.210 – Drill and Grout, and shall include drilling of holes, reinforcing steel, grout, and furnishing all labor, equipment, materials, accessories and incidentals to complete work to the satisfaction of the Engineer.

D. Repairing existing foundation with grout bags will be measured by the cubic yard, complete in place under Item 0334.120 – Concrete Foundation, and shall include placing grout bags, filling with grout, and furnishing all labor, equipment, materials, accessories, and incidentals to complete the work to the satisfaction of the Engineer.

E. Separate measurement and payment will not be made for cast-in-place concrete work required for mini-pile pier caps used to support the pedestrian platform and for other concrete work associated with the platform under this Section, but all costs in connection therefore, shall be considered incidental to Item 0613.019 Access Platform.

F. Separate measurement and payment will not be made for cast-in-place concrete work required for slabs and for other concrete work associated with the pedestrian overpass and access ramps under this Section, but all costs in connection therefore, shall be considered incidental to Item 0211.615 Pedestrian Overpass.

G. Separate measurement and payment will not be made for cast-in-place concrete work required for retaining walls along walkway under this Section, but all costs in connection therefore, shall be considered incidental to Item 0242.131 Retaining Wall A or Item 0242.132 Retaining Wall B.

H. Separate measurement and payment will not be made for cast-in-place concrete work required for the prefabricated maintenance structure, but all costs in connection therefore, shall be considered incidental to Item 1365.000 Prefabricated Structure.

I. Cast-in Place Concrete for the foundation pad for the future vending enclosure will be measured by the cubic yard, complete in place under Item 0329.670 – Cast-in-Place Concrete Slab, and shall include placing and finishing the concrete slab and furnishing all labor, equipment, materials, accessories, and incidentals to complete the work to the satisfaction of the Engineer.

J. Cast-in Place Concrete for concrete sidewalks will be measured by the square yard, complete in place under Item 0263.150 – Concrete Sidewalks, and shall include placing and finishing the concrete sidewalk and furnishing all labor, equipment, materials, accessories, and incidentals to complete the work to the satisfaction of the Engineer.

K. Separate measurement and payment will not be made for all other cast-in-place concrete work under this Section, but all costs in connection therefore, shall be considered incidental to the items of work to which they pertain.

4.2 PAYMENT

A. Payment for cast-in-place concrete will be made at the Contract unit price for the quantities as specified above.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0211.615	PEDESTRIAN OVERPASS	LS
0242.131	RETAINING WALL A	LS
0242.132	RETAINING WALL B	LS
0263.150	CONCRETE SIDEWALKS	SY
0321.210	DRILL AND GROUT	LF
0329.670	CAST-IN-PLACE CONCRETE SLAB	CY
0330.073	4000 PSI ¾" AGGREGATE CONCRETE	CY
0330.074	4000 PSI 1-1/2" AGGREGATE CONCRETE	CY
0334.120	CONCRETE FOUNDATION	CY
0613.019	ACCESS PLATFORM	LS
1365.000	PREFABRICATED STRUCTURES	LS

END OF SECTION

SECTION 03370
PENETRATING CONCRETE SEALER

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section specifies furnishing and applying penetrating concrete sealer - anti-graffiti coating where shown on the Contract Drawings and as indicated herein.

B. All exposed surface of abutment walls, retaining walls, wall caps, soldier pile walls, and pier columns shall be coated with penetrating sealer – anti-graffiti coating.

C. Coating systems a low VOC system in conformance with Massachusetts DEP Air Pollution Control Regulations 310 CMR 7.25-7.60 sub-part 11b Architectural & Industrial Maintenance Coatings Emission Standards TABLE 310 CMR 7.25(11) VOC Emission Limitations for Architectural or Industrial Maintenance Coatings.

1.02 SUBMITTALS

A. Submit material safety data sheets and certificates that the proposed products are chloride free.

B. Submit manufacturers' product data indicating type, chemical make-up, application methods, and mixing ratios.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Anti-graffiti (AG) coatings suitable for repeated cleaning are of two generic types:
1. Low gloss, low-build, two-component, aliphatic polyurethane coatings, clear versions only. (May use fluoro-polymer chemistry to enhance anti-graffiti performance.)
2. Organo-silicate coatings based on silane/siloxane chemistry, clear versions only. (Fluoro-polymer chemistry may be incorporated to enhance anti-graffiti performance.)

B. Products with adequate film hardness and gloss-retention for AG service include, in alphabetical order:

1. *Polyurethane type*:
Carboline Carbothane® Clear coat AG (gloss and satin finish)
DuPont Imron® 2.8 FT-C clear coat

2. *Organo-silicate type:*
Ameron PSX 700 clear
Carboline Carboxane® 2000 clear (gloss and satin finish)

2.02 CLEANING SOLUTIONS

A. Cleaning solutions shall be as approved or recommended by the AG coating manufacturer to maximize cleaning effect without harming the AG coating.

B. Cleaning solutions and procedures shall not damage the substrate beneath the AG coating except where this is approved by the MBTA Engineer (e.g., because the substrate will be newly coated.)

C. Cleaning solutions shall meet MBTA requirements for personnel exposure, safe handling and disposal.

PART 3 - EXECUTION

3.01 PREPARATION OF CONCRETE SURFACES

A. All substrates to be coated shall be clean, sound, and surface dry. Substrates shall be free of standing water, frost, dust, laitance, grease, oil, curing, compounds, waxes, impregnations, foreign particles, other coatings, and disintegrated materials.

B. All projections, rough spots, etc., shall be dressed off. Entire surface to be coated shall be mechanically prepared, i.e. - sandblasted, high-pressure water blasted, etc., to achieve above prescribed surface condition as approved by Engineer.

C. Make substrate repairs in accordance with Section 03300 as required by Engineer to achieve a smooth, level surface.

3.02 APPLICATION

A. Do not thin. Apply directly from container. Apply in well ventilated areas only, free from open flame. Vegetation, metal, and glass shall be protected from overspray. Keep materials covered when not being used.

B. Apply coating to all exposed-to-view surfaces of concrete at all piers, foundations, retaining wall, abutments and all other concrete elements exposed to weather.

C. Placement Procedure

1. Penetrating sealer – anti-graffiti coating shall be applied only to approved, prepared surfaces with high-quality brushes, rollers or spray equipment.

2. Coating shall be applied at ambient and substrate temperatures between 35 and 90 degrees F and shall follow manufactures recommendations.

3. When applying the coating, never stop the application until the entire surface has been coated, if possible. If impossible always discontinue at an edge, corner, or joint. Never let a previously coated film dry, always coat into a wet film. Always coating at a 45 degree angle to an edge, corner, or joint.

4. Horizontal Surfaces: apply a saturating coat to point of rejection. Residues and puddles shall be broomed out until they completely penetrate surface. Roll out or

redistribute any excess sealer that does not penetrate after 10 minutes.

5. Vertical Surfaces: apply a saturating coat from bottom up with enough material going on to produce an 8-inch rundown. On porous surfaces, a second coat shall be reapplied in same manner after first coat penetrates.

D. Clean-up: all tools and overspray or drippings onto metal or glass or plastic shall be immediately cleaned using an approved solvent.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Measurement for applying Penetrating Concrete Sealer/Anti-Graffiti Compound, Anti-Graffiti Coating will be made on a square yard basis, complete in place. Separate measurement and payment will not be made cleaning and preparation of the surface to the coating manufacturer's specification. Limits of compound shall be as shown as noted on the contract and/or as directed by the Engineer.

4.02 PAYMENT

A. Payment for Penetrating Concrete Sealer/Anti-Graffiti Compound, Anti-Graffiti Coating will be paid at the square yard price as specified above. Payment shall constitute full compensation for cleaners, water, disposal, coatings, labor, tools, materials, equipment, transportation and all incidentals in accordance with the above described work and to the complete satisfaction of the Engineer

4.03 PAYMENT ITEMS

Item No.	Description	Unit
Item 986.102	Anti-Graffiti Coating	SY

END OF SECTION

SECTION 03410

PLANT-PRECAST STRUCTURAL CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies plant-precast structural concrete units, including the following:

1. Precast concrete deck beams.
2. Prestressed concrete box beams.
3. Precast prestressed double tee platform panels

B. The work under this section includes, but is not limited to furnishing and installing precast concrete platform panels as indicated on the Drawings and as specified herein.

1. Panels shall be manufactured with non-skid walking surface and shall be provided with a recess to receive field applied modular tactile surfaces as indicated on the contract documents and as approved by the engineer.

C. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 05100 - STRUCTURAL STEEL
2. Section 05500 - MISCELLANEOUS METAL
3. Section 07920 – JOINT SEALANTS; elastomeric joint sealants and sealant backings.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Calculations – South Acton Station Precast Double Tees - ONLY:

1. Except as specifically excluded below, submit for review design calculations stamped and signed by an Engineer registered in the State of Massachusetts for all elements to be fabricated under this Section and a description of their lifting method and erection procedure, properly coordinated with the Shop Drawings. Calculations shall be prepared using U.S. units of measure.
   a. Loading for Design:
      1) Initial handling and erection stresses.
      2) All service dead and live loads as specified on the Contract Drawings.
      3) All other loads specified for member, where applicable.
   b. Design calculations for products not completed on the Contract Drawings shall be prepared by a registered Engineer experienced in precast, prestressed concrete design.
      1) Conform, in all respects, to the requirements of ACI 318.
      2) Provide computations showing the change in shape of the precast member due to the influence of the prestressing force.
   c. Design calculations for precast connections including, but not limited to, dap reinforcing, and tee to tee flange connections.

d. Lifting method and erection procedure shall be submitted to and agreed upon by the Erection Sub-Contractor

C. Design Mixes: For each concrete mix.

D. Shop Drawings: Detail fabrication and installation of precast structural concrete units. Indicate member locations, plans, elevations, dimensions, shapes, cross sections, openings, and types of reinforcement, including special reinforcement.

1. Indicate welded connections by AWS standard symbols. Detail loose and cast-in hardware, inserts, connections, and joints, including accessories.
2. Indicate locations and details of anchorage devices to be embedded in other construction.

E. Samples: For each type of finish indicated on exposed surfaces of precast structural concrete units, in sets of 3, illustrating quality of finishes, colors, and textures; approximately 12 by 12 by 2 inches.

F. Samples of bearing pads.

G. Welding Qualifications: Copies of qualifications for welding procedures and personnel.

H. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

I. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:

1. Concrete materials.
2. Reinforcing materials and prestressing tendons.
3. Admixtures.
4. Bearing pads.
   Inspection and test reports from independent testing agency.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed precast structural concrete work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Fabricator Qualifications: A firm that complies with the following requirements and is experienced in manufacturing precast structural concrete units similar to those indicated for this Project and with a record of successful in-service performance. Plant certification is required by Precast Concrete Institute; plant subject to inspection by the Engineer.

C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.

D. Design Standards: Comply with ACI 318 and the design recommendations of PCI MNL 120, "PCI Design Handbook--Precast and Prestressed Concrete".

E. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and camber and dimensional tolerances for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products".

F. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel"; and AWS D1.4, "Structural Welding Code--Reinforcing Steel".

G. Calculated Fire Resistance: Where indicated, provide precast structural concrete units whose fire resistance has been calculated according to PCI MNL 124, "Design for Fire Resistance of Precast Prestressed Concrete", or ACI 216.1/TMS 0216.1, "Standard Method for Determining Fire Resistance of Concrete and Masonry Construction Assemblies", and is acceptable to authorities having jurisdiction.

H. Fire-Test-Response Characteristics: Provide precast structural concrete units that comply with the following requirements:

1. Fire-response testing was performed by UL, ITS or another testing and inspecting agency that is acceptable to authorities having jurisdiction and that performs testing and follow-up services.
2. Fire-resistance-rated assemblies, which are indicated by design designations from UL's "Fire Resistance Directory", from ITS's "Directory of Listed Products" or from the listings of another testing and inspecting agency, are identical in materials and construction to those tested per ASTM E 119.
3. Products are identified with appropriate markings of applicable testing and inspecting agency.

I. The tolerances for precast platform panel /double tees fabrication shall not exceed the following criteria.

1. Panel length - 1/8 inch,
2. Panel width - 1/8 inch,
3. Panel squareness - no tolerance deviations,
4. Panel thickness - 1/8 inch,
5. Draft on sides and ends of panels - 1/8 inch
6. Opening: cast within unit - 1/8 inch
7. Positioning of insert groups - 1/8 inch
8. Reinforcement - 1/4 inch

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver precast structural concrete units to Project site in such quantities and at such times to ensure continuity of installation. Store units at Project site to prevent cracking, distorting, warping, staining, or other physical damage, and so markings are visible.

B. Lift and support units only at designated lifting and supporting points as shown on Shop Drawings.

1.5 SEQUENCING

A. Furnish anchorage items to be embedded in other construction without delaying the Work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 - PRODUCTS

2.1 MOLD MATERIALS

A. Molds: Provide molds and, where required, form-facing materials of metal, plastic, wood, or another material that is nonreactive with concrete and dimensionally stable to produce continuous and true precast concrete surfaces within fabrication tolerances and suitable for required finishes.

2.2 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed. All reinforcing steel shall be epoxy coated.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

C. Steel Bar Mats: ASTM A 184/A 184M, assembled with clips, as follows:

1. Steel Reinforcement: ASTM A 615/A 615M, deformed bars.

D. Plain-Steel Wire: ASTM A 82, galvanized.

E. Deformed-Steel Wire: ASTM A 496.

F. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from galvanized steel wire into flat sheets.

G. Deformed-Steel Welded Wire Fabric: ASTM A 497, flat sheet.

H. Supports: Manufacturer's bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place according to CRSI's "Manual of Standard Practice", PCI MNL 116, and as follows:

1. For uncoated reinforcement, use CRSI Class 1 plastic-protected bar supports.
2. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

2.3 PRESTRESSING TENDONS

A. Prestressing Strand: ASTM A 416/A 416M, Grade 270, uncoated, 7-wire, low-relaxation strand.

2.4 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type III cement mitigated with a pozzolan to prevent alkali-silica reactivity.

B. Normal-Weight Aggregates: Except as modified by PCI MNL 116, ASTM C 33.

C. Lightweight Aggregates: ASTM C 330.

D. Water: Potable, free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 116.

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

F. Fly Ash Admixture: ASTM C 618, Class C only.

G. Silica Fume Admixture: ASTM C 1240.

2.5 STEEL CONNECTION MATERIALS

A. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M.

B. Carbon-Steel Headed Studs: ASTM A 108, AISI 1018 through AISI 1020, cold finished; AWS D1.1, Type A or B, with arc shields.

C. Malleable Steel Castings: ASTM A 47.

D. Deformed-Steel Wire or Bar Anchors: ASTM A 496 or ASTM A 706/A 706M.

E. Carbon-Steel Bolts and Studs: ASTM A 307, Grade A; carbon-steel, hex-head bolts and studs; carbon-steel nuts; and flat, unhardened steel washers.

F. Finish: For exterior steel items, steel in exterior walls, and items indicated for galvanizing, apply zinc coating by hot-dip process according to ASTM A 123/A 123M, after fabrication, and ASTM A 153/A 153M, as applicable.

1. Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035A or SSPC-Paint 20.

G. Welding Electrodes: Comply with AWS standards.

H. Accessories: Provide clips, hangers, plastic shims, and other accessories required to install precast structural concrete units.

2.6 STAINLESS-STEEL CONNECTION MATERIALS

A. Stainless-Steel Plate: ASTM A 666, Type 304, of grade suitable for application.

B. Stainless-Steel Bolts and Studs: ASTM F 593, alloy 304 or 316, hex-head bolts and studs; stainless-steel nuts; and flat, stainless steel washers.

C. Stainless-Steel Headed Studs: ASTM A 276.

2.7 BEARING PADS

A. Provide bearing pads for precast structural concrete units as follows:

1. Type: Either plain bearing pads, consisting of elastomer only, or laminated bearing pads, consisting of layers of elastomer restrained at their interfaces by bonded laminates, as indicated.
2. Elastomer portion of the elastomeric compound: 100 percent polychloroprene (neoprene).
3. Plain Type: Molded individually to size or cut from previously molded strips or slabs, or extruded and cut to length: cut edges at least as smooth as ANSI 250 finish, 50 to 70 Shore A durometer, minimum tensile strength 2250 psi per ASTM D 412.
4. Laminated Type: All components laminated bearing pads molded together into an integral unit and all edges of the non-elastic lamination covered by a minimum of 1/8 inch of elastomer - except at laminate restraining devices and around holes that will be entirely closed on the finished structure. Laminates: rolled mild steel sheets conforming to ASTM A 36, A 570, Grade C or D or A61 1, Grade C or D.
5. Bearing pads shall be bonded with epoxy to both the bridge seat and precast concrete beams.

2.8 GROUT MATERIALS

A. Sand-Cement Grout: Portland cement, ASTM C 150, Type I or II, and clean, natural sand, ASTM C 144. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, Portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, of consistency suitable for application.

2.9 CONCRETE MIXES

A. Prepare design mixes for each type of concrete required.

1. Limit use of fly ash and silica fume to not exceed, in aggregate, 25 percent of Portland cement by weight.

B. Design mixes may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast structural concrete fabricator's option.

C. Limit water-soluble chloride ions to the maximum percentage by weight of cement permitted by ACI 318.

D. Normal-Weight Concrete: Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 6500 psi.
2. Maximum Water-Cementitious Materials Ratio: 0.40.
3. Slump: 4 inches maximum.
4. Units subject to freeze-thawing shall be air-entrained. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows, with a tolerance of plus or minus 1-1/2 percent:
   a. Air Content: 3 to 6 percent.

E. Lightweight Concrete: Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.2, with materials to be used on Project, to provide lightweight concrete with the following properties:

1. Compressive Strength (28 Days): 5000 psi.
2. Unit Weight: Calculated equilibrium unit weight of 115 lb/cu. ft., plus or minus 3 lb/cu. ft. (48 kg/cu. m), according to ASTM C 567.
3. Add air-entraining admixture at manufacturer's prescribed rate to result in lightweight concrete at point of placement having an air content as follows:
   a. Air Content: 4 to 6 percent for 3/4-inch-nominal maximum aggregate size.

F. Other Admixtures: Use water-reducing, high-range water-reducing, water-reducing and accelerating, or water-reducing and retarding admixtures according to manufacturer's written instructions.

G. Concrete Mix Adjustments: Concrete mix design adjustments may be proposed if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

2.10 FABRICATION

A. Formwork: Accurately construct forms, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for pretensioning and detensioning operations. Maintain formwork to provide completed precast concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances.

1. Coat surfaces of forms with bond-breaking compound before reinforcement is placed. Provide commercial-formula, form-coating compounds that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces requiring bond or adhesion. Apply in compliance with manufacturer's written instructions.
2. Unless forms for precast, prestressed concrete units are stripped before detensioning, design forms so stresses are not induced in precast concrete units because of deformation or movement of concrete during detensioning.

B. Built-in Anchorages: Accurately position built-in anchorage devices and secure to formwork. Locate anchorages where they do not affect position of main reinforcement or concrete placement. Do not relocate bearing plates in units unless approved by Engineer.

C. Cast-in openings larger than 10 inches in diameter or 10 inches square according to Shop Drawings. Smaller holes may be field cut by trades requiring them, as approved by Engineer.

D. Reinforcement: Comply with recommendations in Concrete Reinforcing Steel Institute's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete.
2. Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete-placement operations. Locate and support reinforcement by metal chairs, runners, bolsters, spacers, and hangers, as required.
3. Place reinforcement to obtain at least the minimum coverage for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
4. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Prestress tendons for precast structural concrete units by either pretensioning or posttensioning methods. Comply with Precast Concrete Institute MNL 116.

1. Delay detensioning until concrete has reached at least 70 percent of its compressive strength as established by test cylinders cured under the same conditions as concrete.
2. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.
3. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat-cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.

F. Mix concrete according to PCI MNL 116 and requirements in this Section. After concrete batching, no additional water may be added.

G. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units. Comply with requirements in PCI MNL 116 for measuring, mixing, transporting, and placing concrete.

H. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items. Use equipment and procedures complying with PCI MNL 116.

I. Comply with ACI 306.1 procedures for cold-weather concrete placement.

J. Comply with ACI 305R recommendations for hot-weather concrete placement.

K. Identify pickup points of precast concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint casting date on each precast concrete unit on a surface that will not show in finished structure.

L. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture.

M. Product Tolerances: Fabricate precast structural concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished unit complies with PCI MNL 116 product tolerances.

N. Finish formed surfaces of precast structural concrete as indicated for each type of unit, and as follows:

1. Commercial Finish: Remove fins and large protrusions and fill large holes. Rub or grind ragged edges. Faces are to be true, well-defined surfaces.

O. Screed finish unformed surfaces. Strike off and consolidate concrete with vibrating screeds to a uniform finish. Hand screed at projections.

1. Apply scratch finish to precast concrete units that will receive concrete topping after installation. After initial strikeoff, transversely scarify surface to provide ridges approximately 1/4 inch deep.

P. Recess prestressing tendons a minimum of 1/2 inch, fill recesses with grout, and apply a sack finish to vertical ends of precast concrete units.

2.11 DECK BEAM UNITS

A. Type: Plant-fabricated precast concrete units, solid with no design voids in cross-section as shown on the Contract Documents.

B. Furnish units free of voids, imperfections and honeycombs.

C. Provide standard finish to precast concrete units.

D. Reinforce units to resist transportation and erection stresses.

E. Coordinate with other trades for installation of cast-in items.

F. Include cast-in weld plates where required.

G. Provide solid, monolithic, precast reinforced concrete deck beam units fabricated to dimensions and details indicated on the Contract Documents.

H. Fabricate units with transverse ducts for post-tensioning butted deck beam units together in stages as indicated on the Contract Documents

2.12 BOX BEAM UNITS

A. Type: Plant-fabricated, precast, prestressed concrete box beam units.

B. Furnish units free of voids, imperfections and honeycombs.

C. Provide standard finish to precast concrete units, unless otherwise indicated.

D. Reinforce units to resist transportation and erection stresses.

E. Include cast-in weld plates where required.

F. Coordinate with other trades for installation of cast-in items.

G. Fabricate units with transverse ducts for post-tensioning butted box beam units together in stages as indicated on the Contract Documents.

2.13 DOUBLE TEE UNITS

A. Type: Plant-fabricated, precast, prestressed concrete double tee units.

B. Furnish units free of voids, imperfections and honeycombs.

C. Provide standard finish to precast concrete units for acceptance of MMA sealer, unless otherwise indicated.

D. Reinforce units to resist transportation and erection stresses.

E. Include cast-in weld plates where required.

F. Coordinate with other trades for installation of cast-in items.

2.14 SOURCE QUALITY CONTROL

A. Contractor shall engage an independent testing agency to evaluate precast structural concrete fabricator's quality-control and testing methods.

1. Allow testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with testing agency and provide samples of materials and concrete mixes as may be requested for additional testing and evaluation.
2. Notification Point - Notify Engineer at least 3 days in advance of testing. Testing may be witnessed by the Engineer.

B. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL 116 requirements.

C. Strength of precast concrete units will be considered deficient if units fail to comply with PCI MNL 116 requirements, including the following:

1. Units fail to comply with compressive-strength test requirements.
2. Reinforcement and prestressed tendons of units do not comply with fabrication requirements.
3. Concrete curing and protection of units against extremes in temperature fail to comply with requirements.
4. Units are damaged during handling and erecting.

D. Testing: If there is evidence that the strength of precast concrete units may be deficient or may not comply with PCI MNL 116 requirements, Contractor shall employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42.

1. A minimum of three representative cores will be taken from units of suspect strength, from locations directed by Engineer.
2. Cores will be tested, after immersion in water, in a wet condition per ACI 301 if units will be wet under service conditions.
3. Strength of concrete for each series of 3 cores will be considered satisfactory if the average compressive strength is equal to at least 85 percent of the 28-day design compressive strength and no single core is less than 75 percent of the 28-day design compressive strength.
4. Test results will be made in writing on the same day that tests are performed, with copies to Engineer, Contractor, and precast concrete fabricator. Test reports will include the following:
   a. Project identification name and number.
   b. Date when tests were performed.
   c. Name of precast concrete fabricator.
   d. Name of concrete testing agency.
   e. Identification letter, name, and type of precast concrete unit or units represented by core tests; design compressive strength; type of break; compressive strength at break, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.

E. Patching: If core test results are satisfactory and precast concrete units comply with requirements, clean and dampen core holes and solidly fill with precast concrete mix that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.

F. Dimensional Tolerances: Units with dimensions smaller or larger than required and not complying with tolerance limits may be subject to additional testing.

1. Precast concrete units with dimensions larger than required will be rejected if the appearance or function of the structure is adversely affected or if larger dimensions interfere with other construction. Repair or remove and replace rejected units, as required, to comply with construction conditions.

G. Defective Work: Precast concrete units that do not comply with requirements, including strength, manufacturing tolerances, and finishes, are unacceptable. Replace with precast concrete units that comply with requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Bearing Pads: Install bearing pads as precast concrete units are being erected. Set pads on true, level, and uniform bearing surfaces and maintain in correct position until precast concrete units are placed.

B. Install precast structural concrete. Shore and brace precast concrete units to maintain location, stability, and alignment until permanent connections are installed.

C. Welding: Perform welding in compliance with AWS D1.1 and AWS D1.4, with qualified welders using qualified welding procedures.

1. Protect precast concrete units and bearing pads from damage by field welding or cutting operations and provide noncombustible shields as required.
2. Repair damaged metal surfaces by cleaning and applying a coat of galvanized repair paint to galvanized surfaces.
3. Repair damaged metal surfaces by cleaning and repriming damaged painted surfaces.

D. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed concrete units unless approved by Engineer.

E. Erection Tolerances: Install precast concrete units level, plumb, square, and true, without exceeding the recommended erection tolerances in PCI MNL 127, "Recommended Practice for Erection of Precast Concrete".

F. Grouting Connections and Joints: After precast concrete units have been placed and secured, grout open spaces at keyways, connections, and joints as follows:

1. Provide forms or other approved method to retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces. Keep grouted joints damp for not less than 24 hours after initial set. Promptly remove grout material from exposed surfaces before it hardens.

3.3 FIELD QUALITY CONTROL

A. Testing: Contractor shall engage a qualified independent testing and inspecting agency to perform field tests and inspections.

B. Notification Point - Field welds and connections using high-strength bolts will be subject to tests and inspections. Notify the Engineer 24 hours in advance of high-strength bolting.

C. Testing agency will report test results promptly and in writing to Contractor and Engineer.

D. Remove and replace work that does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.4 CLEANING

A. Clean exposed surfaces of precast concrete units after erection to remove weld marks, other markings, dirt, and stains.

1. Wash and rinse according to precast concrete fabricator's written recommendations. Protect other work from staining or damage due to cleaning operations.
2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. No separate measurement will be made for the individual constituent elements of plant-precast and precast prestressed structural concrete but all costs included therewith shall be included in the Contract Lump Sum prices for furnishing and installing all items as indicated on the Contract Documents. This work shall include all plans, calculations, submissions, including all labor, equipment, transportation, preparations, reinforcing steel, formwork, bearing pads, accessories and incidentals to complete work to the satisfaction of the engineer.

4.2 PAYMENT

A. Payment for plant-precast structural concrete will be made at the Contract unit prices for the quantities as specified above.

B. All work associated with the precast concrete deck beam superstructure at the Waltham Culvert (MP 8.65) will be paid at the Contract Lump Sum Price Bid for Item 0342.000 – Precast Structural Concrete, which price shall include all costs associated with furnishing and installing precast concrete butted deck beams as shown on the Contract Documents, including all shop drawings, submittals, equipment, materials, reinforcing steel, inserts, bearing pads, labor, transportation, post-tensioning and incidentals required to perform the work to the satisfaction of the Engineer.

C. All work associated with the precast-prestressed concrete butted box beam superstructure at the West Acton Bridge (MP 27.46) will be paid at the Contract Lump Sum Price Bid for Item 0343.003 – Precast Prestressed Concrete Box Beams, which price shall include all costs associated with furnishing and installing precast prestressed concrete butted box beams as shown on the Contract Documents, including all shop drawings, submittals, equipment, materials, reinforcing steel, inserts, bearing pads, labor, transportation, post-tensioning and incidentals required to perform the work to the satisfaction of the Engineer.

D. All work associated with the precast-prestressed concrete double tee platforms at the South Acton Station will be paid at the Contract Lump Sum Price Bid for Item 0613.019 – Access Platform which price shall include all costs associated with the design, furnishing and installing precast prestressed concrete double tee beams as shown on the Contract Documents, including all design, shop drawings, submittals, equipment, materials, reinforcing steel, inserts, bearing pads, labor, transportation, and incidentals required to perform the work to the satisfaction of the Engineer.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0342.000	PRECAST STRUCTURAL CONCRETE	LS
0343.003	PRECAST PRESTRESSED CONCRETE BOX BEAMS	LS
0613.019	ACCESS PLATFORM	LS

END OF SECTION

SECTION 03603

EPOXY COMPOUNDS FOR CONCRETE RESTORATION AND TOPPING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies epoxy compounds for concrete restoration and topping for existing or new construction.

1.2 SUBMITTALS

A. Submit certificates of compliance, from independent testing laboratories, approved by Engineer, attesting to compliance with data requirements of the Section.

B. Submit manufacturer's application and installation instructions for products.

1.3 JOB CONDITIONS

A. Safety: Applicators shall wear protective clothing, gloves, goggles, barrier creams and take such other precautionary measures as are recommended by manufacturer or any federal, state or municipal rule, law, or regulation having jurisdiction with special attention being directed at adequate ventilation and dissipation of noxious fumes and other byproducts generated in the mixing and application of products specified herein.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Qualification of Resin Types based on examination under requirements of ASTM C881:

Grade	Type I	Type II	Type III
1	Class A - N/A Class B - Resin Type A Class C - Resin Type A	Class A - N/A Class B - Resin Type A Class C - Resin Type A	Class A - N/A Class B - N/A Class C - Resin Type D
2	Class A - N/A Class B - Resin Type B Class C - Resin Type B	Class A - N/A Class B - Resin Type B Class C - Resin Type B	Class A - N/A Class B - Resin Type E Class C - Resin Type E
3	Class A - N/A Class B - Resin Type C Class C - Resin Type G	Class A - N/A Class B - Resin Type C Class C - Resin Type C	Class A - N/A Class B - Resin Type F Class C - Resin Type F

B. Definitions

1. Type I: For use in bonding hardened concrete and other materials to hardened concrete.

2. Type II: For use in bonding freshly mixed concrete to hardened concrete.
3. Type III: For use in bonding skid-resistant materials to concrete and as a binder in epoxy mortars and epoxy concrete.
4. Grade 1: Low viscosity (less than 2,000 cps)
5. Grade 2: Medium viscosity (2,000 - 10,000 cps)
6. Grade 3: Non-sagging consistency
7. Class A: For use below 40°F
8. Class B: For use between 40° - 60°F
9. Class C: For use above 60°F
10. N/A: Not Available

2.2 RESIN TYPE COMPOUNDS

A. Resin Type A Compound is a two-component, solvent free, moisture insensitive, multipurpose, epoxy resin adhesive.

1. Physical Properties:

a. Compressive Properties (ASTM D-695):

Compressive Strength, psi	Neat			Mortar		
	40F	73F	90F	40F	73F	90F
4 hour	-	-	-	-	-	800
8 hour	-	10	3,200	-	400	4,100
16 hour	-	3,600	6,300	-	4,900	5,700
1 day	-	6,800	9,100	120	5,000	6,900
3 day	3,600	9,800	10,500	6,200	6,800	7,000
7 day	8,000	10,700	10,500	6,300	7,900	8,800
14 day	10,300	11,100	10,500	6,800	8,500	8,800
28 day	12,400	11,700	10,500	7,000	8,600	8,800

	NEAT	MORTAR (1:5)
b. Modulus of Elasticity, Psi 28 day	3.5×10^5	8.1×10^5
c. Tensile Properties (ASTM D-638): 14 day - Tensile Strength Elongation at Break Modulus of Elasticity	8,400 psi 4.2% 4.1×10^5 psi	840 psi 0.3% 7.6×10^5 psi
d. Flexural Properties (ASTM D-790): 14 day - Flexural Strength (Modulus of Rupture) Tangent Modulus of Elasticity in Bending	14,000 psi 3.7×10^5 psi	2,200 psi 9.5×10^5 psi
e. Shear Strength (ASTM D-732): 14 day - Shear Strength	5,100 psi	2,300 psi
f. Deflection Temperature (ASTM D-648): 14 day - Deflection Temperature	127°F	129°F
g. Bond Strength (ASTM C-882): Hardened concrete to hardened concrete 2 day (dry cure) - Bond Strength 14 day (moist cure) - Bond Strength	2,800 psi 2,800 psi	
h. Water Absorption (ASTM D-570) 7 day - Total Water Absorption (2 hour boil)	1.1%	

B. Resin Type Compound B is a two-component, solvent-free, moisture-insensitive, high modulus, high-strength, structural epoxy paste adhesive.

1. Physical Properties:

a. Compressive Properties (ASTM D-695):

Compressive Strength, psi	40F	73F	90F
8 hours	-	-	100
16 hours	-	2,400	4,500
1 day	-	4,600	6,400
3 day	800	8,100	8,200
7 day	7,200	9,500	8,200
14 day	8,100	9,500	8,200
28 day	8,800	9,500	8,200

Modulus of Elasticity, psi:

28 day 4.4 X 105 psi

b. Tensile Properties (ASTM D-638):	
14 day - Tensile Strength	4,800 psi
Elongation at Break	1.9%
Modulus of Elasticity	3.2×10^5 psi
c. Flexural Properties (ASTM D-790):	
14 day - Flexural Strength (Modulus of Rupture)	7,400 psi
Tangent Modulus of Elasticity in Bending	4.7×10^5 psi
d. Shear Strength (ASTM D-732):	
14 day Shear Strength	5,900 psi
e. Water Absorption (ASTM D-570):	
7 day Total Water Absorption (2 hour boil)	0.7%
f. Deflection Temperature (ASTM D-648):	
14 day - Deflection Temperature (fiber stress loading= 264 psi)	121°F
g. Bond Strength (ASTM D-882):	
14 day (moist cure) - Plastic concrete to Hardened Concrete	1,900 psi
Plastic Concrete to Steel	1,900 psi

C. Resin Type Compound C is a two-component, solvent-free, moisture insensitive, high modulus, structural epoxy paste adhesive.

1. Physical Properties:

a. Compressive Properties (ASTM D-695):

Compressive Strength, psi	40F	73F	90F
2 hour	-	-	900
4 hour	-	140	5,400
8 hour	-	6,800	8,800
16 hour	400	9,600	10,100
1 day	3,900	9,800	11,700
3 day	6,700	11,300	11,900
7 day	9,100	12,000	13,000
14 day	10,400	12,000	13,000
28 day	11,200	12,000	13,000

b. Modulus of Elasticity, psi 28 day	 8.3×10^5
c. Tensile Properties (ASTM D-638): 14 day - Tensile Strength Elongation at Break Modulus of Elasticity	 3,600 psi 0.4% 7.5×10^5 psi
d. Flexural Properties (ASTM D-790): 14 day - Flexural Strength (Modulus of Rupture) Tangent Modulus of Elasticity in Bending	 4,400 psi 1.0×10^5 psi
e. Shear Strength (ASTM D-732): 14 day - Shear Strength	 3,400 psi
f. Bond Strength (ASTM C-882): Hardened Concrete to Hardened Concrete 2 day (dry cure) - Bond Strength 14 day (moist cure) - Bond Strength	 3,300 psi 2,400 psi
g. Deflection Temperature (ASTM D-648): 14 day - Deflection Temperature (fiber stress loading = 264 psi)	 128°F
h. Water Absorption (ASTM D-570): 7 day - Total Water Absorption (2 hour boil)	 0.79%

D. Resin Type Compound D is a two-component, solvent-free, moisture-insensitive, epoxy resin binder.

1. Physical Properties:

a. Compressive Properties Mortar 1:6 (ASTM D-695):

Compressive Strength, psi	40F	73F	90F
4 hour	-	-	500
8 hour	-	400	2,200
16 hour	20	2,100	4,600
1 day	40	2,600	4,700
3 day	1,400	4,900	5,500
7 day	3,500	5,400	6,200
14 day	4,500	6,000	6,200
28 day	4,600	6,100	6,200

b. Modulus of Elasticity, psi: 28 days	 7.6×10^5 psi
c. Tensile Properties Mortar 1:6 (ASTM D-638): 14 day - Tensile Strength Elongation at Break Modulus of Elasticity	 1,300 psi 0.2% 6.6×10^5 psi
d. Flexural Properties Mortar 1:6 (ASTM D-790): 14 day - Flexural Strength (Modulus of Rupture) Tangent Modulus of Elasticity in Bending	 2,300 psi 1.2×10^6 psi
e. Shear Strength Mortar 1:6 (ASTM D-732): 14 day - Shear Strength	 2,000 psi
f. Water Absorption Neat (ASTM D-570): 7 day - Total Water Absorption (2 hour boil)	 1.17%
g. Deflection Temperature Mortar 1:6 (ASTM D-648): 14 day - Deflection Temperature (fiber stress loading=66psi	 111°F
h. Bond Strength (ASTM D-882) Hardened concrete to hardened concrete 2 day (dry cure) - Bond Strength 14 day (moist cure) - Bond Strength	 1,100 psi 1,600 psi
i. Abrasion Mortar 1:6 (Tabor Abrader): 14 day - Weight loss, 1,000 cycles (H-22 wheel, 1,000 gm weight)	 4.1 gm

E. Resin Type Compound E is a two-component, solvent-free, moisture insensitive, epoxy resin binder.

1. Physical Properties:

a. Compressive Properties Mortar 1:5 (ASTM D-695):

Compressive Strength, psi	40F	73F	90F
4 hour	-	-	100
8 hours	-	100	1,100
16 hour	-	2,700	4,300
1 day	30	3,500	5,200
3 day	600	4,600	6,000
7 day	4,200	5,400	6,200
14 day	6,200	6,000	6,200
28 day	6,300	6,100	6,200

b. Modulus of Elasticity, psi: 28 days	 7.7×10^5 psi
c. Tensile Properties Mortar 1:5 (ASTM D-638) 14 day - Tensile Strength Elongation at Break Modulus of Elasticity	 1,100 psi 0.2% 5.4×10^5 psi
d. Flexural Properties Mortar 1:5 (ASTM D-790) 14 day - Flexural Strength (Modulus of Rupture) Tangent Modulus of Elasticity in Bending	 2,600 psi 1.1×10^6 psi
e. Shear Strength Mortar 1:5 (ASTM D-732): 14 day - Shear Strength	 2,700 psi
f. Water Absorption Neat (ASTM D-570): 7 day - Total Water Absorption (2 hour boil)	 1.3%
g. Deflection Temperature Mortar 1:5 (ASTM D-648): 14 day - Deflection Temperature (fiber stress loading=66 psi)	 108°F
h. Bond Strength (ASTM D-882): Hardened concrete to hardened concrete 2 day (dry cure) - Bond Strength 14 day (moist cure) - Bond Strength	 1,100 psi 2,000 psi
i. Abrasion Mortar 1:5 (Taber Abrader): 14 day - Weight loss, 1,000 cycles (H-22 wheel; 1,000 gm weight)	 4.6 gm

F. Resin Type Compound F is a two-component, solvent-free, moisture insensitive, low modulus, paste-consistency, non-sagging epoxy resin binder.

1. Physical Properties.

a. Compressive Properties Mortar 1:1 (ASTM D-695):

Compressive Strength, psi	40F	73F	90F
8 hour	-	-	3,500
16 hour	-	3,300	5,600
1 day	-	4,500	5,700
3 day	100	5,600	5,800
7 day	2,200	6,500	5,800
14 day	7,300	7,100	5,900
28 day	7,400	7,200	6,000

b. Modulus of Elasticity, psi: 28 days	 4.0×10^5
c. Tensile Properties Mortar 1:1 (ASTM D-638): 14 day - Tensile Strength Elongation at Break Modulus of Elasticity	 2,400 psi 1.0% 6.1×10^5 psi
d. Flexural Properties Mortar 1:1 (ASTM D-790) 14 day - Flexural Strength (Modulus of Rupture) Tangent Modulus of Elasticity in Bending	 3,900 psi 6.8×10^5 psi
e. Shear Strength Mortar 1:1 (ASTM D-732): 14 day - Shear Strength	 3,300 psi
f. Water Absorption Neat (ASTM D-570): 7 day - Total Water Absorption (2 hour boil)	 0.4%
g. Deflection Temperature Mortar 1:1 (ASTM D-648): 14 day - Deflection Temperature (fiber stress loading=66 psi)	 102°F
h. Bond Strength (ASTM D-882): Hardened concrete to hardened concrete 2 day (dry cure) - Bond Strength 14 day (moist cure) - Bond strength	 2,600 psi 1,700 psi

G. Resin Type Compound G is a two-component, solvent-free, moisture-insensitive, high modulus, high-strength structural epoxy adhesive.

1. Physical Properties:

a. Compressive Properties (ASTM D-695):

Compressive Strength, psi	40F	73F	90F
4 hour	-	-	300
8 hour	-	300	4,300
16 hour	100	7,000	6,900
1 day	1,400	7,000	6,900
3 day	7,600	9,000	8,200
7 day	9,000	9,000	8,200
14 day	9,000	9,000	8,200
28 day	9,000	9,000	8,200

b. Modulus of Elasticity, psi 28 day	 5.4×10^5 psi
c. Tensile Properties (ASTM D-638): 14 day - Tensile Strength Elongation at Break Modulus of Elasticity	 5,400 1.3% 4.1×10^5 psi
d. Flexural Properties (ASTM D-790) 14 day - Flexural Strength (Modulus of Rupture) Tangent Modulus of Elasticity in Bending	 6,700 psi 7.5×10^5 psi
e. Shear Strength (ASTM D-732): 14 day - Shear Strength	 3,700 psi
f. Bond Strength (ASTM D-882): Hardened concrete to hardened concrete: 2 day (dry cure) - Bond Strength 14 day (moist cure) - Bond Strength Hardened concrete to steel: 2 day (dry cure) - Bond Strength 14 day (moist cure) - Bond Strength	 3,000 psi 2,600 psi 3,300 psi 2,600 psi

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. All Compounds: Substrate must be clean and sound. It may be dry or damp, but free of standing water. Remove dust, laitance, grease, curing compounds, impregnations, waxes, foreign particles, and disintegrated materials. Prepare as follows:

1. Concrete - Sandblast or use other approved mechanical means.
2. Steel - Sandblast or white-metal finish.

3.2 MIXING

A. Mix components in strict accordance with manufacturer's instructions.

3.3 APPLICATIONS

A. Resin Type A:

1. To gravity feed cracks - Pour neat compound into vee-notched crack. Continue placement until completely filled. Seal underside of slab prior to filling if cracks reflect through.
2. To pressure inject cracks - Use automated injection equipment or manual method. Set appropriate injection ports based on system used. Seal ports and cracks with recommended sealers. When the epoxy adhesive has cured, inject compound with steady pressure.
3. To anchor bolts, dowels, and pins - Annular space around bolt should not exceed 1/8-in.; depth of embedment is typically 10-15 times the bolt diameter. Grout with neat compound.
4. To seal slabs - Spread neat compound over slab. Allow penetration. Remove excess to prevent surface film. Seal interior slabs and above-grade exterior slabs only.
5. For an epoxy mortar - Prime prepared surface with neat compound. Place prepared epoxy mortar before primer becomes tack-free. Place the epoxy mortar using trowels. Compact and level with vibrating screed or trowels. Finish with finishing trowel. Compound mortar is for interior use only.
6. Limitations:
   a. Minimum application temperature 40°F.
   b. Do not thin with solvents.
   c. Use oven-dried aggregate only.
   d. Maximum epoxy mortar thickness is 12-in per lift.
   e. Epoxy mortar is for interior use only.
   f. Do not seal exterior slabs on grade.
   g. Minimum age of concrete must be 21-28 days, depending on curing and drying conditions, for mortar to seal slabs.
   h. Porous substrates must be tested for moisture-vapor transmission prior to mortar or sealing slabs.
   i. Not for injection of cracks under hydrostatic pressure.
   j. Do not inject cracks greater than 3-in.

B. Resin Type B:

1. To bond fresh concrete to hardened concrete - Apply by brush, roller, broom, or spray. Place fresh concrete while compound is still tacky. If coating becomes glossy and loses tackiness,

remove any surface contaminates then recoat with additional compound. When spraying, use the following or similar equipment: #18 Air-Atomized Spray Gun (#68 fluid nozzle, #68 PB air nozzle, #68-5661 2-gal pressure fluid tank).

2. To anchor bolts, dowels, and pins - Use neat. For efficient transfer of stress, the hole should be no greater in diameter than 3-in. larger than the bar, pin, or rod to be embedded. Depth of embedment is typically 10 to 15 bar diameters.
3. To grout base plates - Add up to 12 parts of oven-dried aggregate to 1 part of mixed compound, by volume. Place grout under base plate. Avoid contact with the underside of the plate. A 1/4 to 3/8-in. space should remain between the top of the grout and the bottom of the plate. Maximum thickness of grout per lift is 12-in. If multiple lifts are needed, allow preceding layer to cool to touch before applying additional layer. The remaining 1/4 to 3/8-in. space should be filled with neat compound. Pour a sufficient quantity of neat epoxy to allow the level to rise slightly higher than the underside of the bearing plate.
4. To gravity feed cracks - Pour neat material into vee-notched crack. Continue placement until completely filled. Seal underside of slab prior to filling if cracks reflect through.
5. Limitations:
   a. Minimum application temperature 40°F.
   b. For spray applications, consult manufacturer.
   c. Use only oven-dried aggregate.
   d. Material is a vapor barrier after cure.
   e. For applications on exterior, on-grade substrates, consult manufacturer.

C. Resin Type C:

1. As a structural adhesive - Apply the neat mixed compound to the mating or non-mating prepared substrates. Work into the substrate for positive adhesion. Secure the bonded unit firmly into place until the adhesion has cured. Glue line should not exceed 1/8-in.
2. To seal cracks for injection grouting - Place the neat mixed material over the cracks to be pressure injected and around each injection port. Allow sufficient time to set before pressure injecting.
3. To anchor bolts, dowels, and pins - Annular space around bolt should not exceed 1/8-in.; depth of embedments is typically 10-15 times the bolt diameter. Grout with neat compound.
4. For interior vertical and overhead patching - Place the prepared mortar in void, working the material into the prepared substrate, filling the cavity. Strike off level. Lifts should not exceed 12-in.
5. Limitations:
   a. Minimum surface temperature 40°F.
   b. Do not thin. Solvents will prevent proper cure.
   c. Use oven-dried aggregate only.
   d. Maximum epoxy mortar thickness is 12-in. per lift.
   e. Epoxy mortar is for interior use only.
   f. Material is a vapor barrier after cure.
   g. Minimum age of concrete must be 21-28 days, depending upon curing and drying conditions, for mortar applications.
   h. Porous substrates must be tested for moisture-vapor transmission prior to mortar applications.
   i. Not for sealing cracks under hydrostatic pressure.

D. Resin Type D:

1. Epoxy Mortar - Prime prepared surface with mixed compound. Apply epoxy mortar by trowel or vibrating screed before primer becomes tack-free. Finish with Finishing trowel.

2. Epoxy Concrete - Consult manufacturer's instructions for placement and finishing of epoxy concrete.
3. Limitations:
   a. Minimum surface temperature 40°F.
   b. Test porous substrates for moisture-vapor transmission prior to any application.
   c. Minimum age of concrete before application is 21-28 days depending upon curing, drying conditions.
   d. Do not apply to exterior slab on grade.
   e. Maximum application thickness on exterior substrates exposed to thermal changes is 2-in.
   f. Do not dilute. Solvents will prevent proper cure.
   g. Use oven-dried aggregates only.
   h. Material is a vapor barrier after cure.

E. Resin Type E:

1. Broadcast Overlay - Prime the prepared substrate with compound. While primer is still tacky, spread mixed compound with a 3/16-in. notched squeegee.
   a. When material levels, broadcast the oven-dried aggregate slowly allowing it to settle in the epoxy binder. Ultimately the broadcast aggregate should be applied to excess at a rate of 2 lb/sq ft.
   b. Remove excess broadcast aggregate after epoxy has set.

2. Epoxy Mortar - Prime prepared substrate with mixed compound. Before primer becomes tack-free, apply epoxy mortar by trowel or vibrating screed. Finish with finishing trowel.
3. Epoxy Concrete - Consult manufacturer's instructions for placement and finishing of epoxy concrete.
4. Limitations:
   a. Minimum surface temperature 40°F.
   b. Porous substrates must be tested for moisture-vapor transmission prior to any application.
   c. Minimum age of concrete before application is 21-28 days depending upon curing and drying conditions.
   d. Do not use on exterior slab on grade.
   e. Maximum thickness 2-in. exterior exposed to thermal change.
   f. Do not dilute. Solvents will prevent proper cure.
   g. Use oven-dried aggregate only.
   h. Material is a vapor barrier after cure.

F. Resin Type F:

1. Apply the compound mortar using a trowel. Work material into surface. Fill void from deepest to shallowest area. Strike off level.
2. Limitations:
   a. Do not thin. Solvents will prevent proper cure.
   b. Use only oven-dried aggregate.
   c. Minimum application temperature 40°F.
   d. Porous substrates must be tested for moisture-vapor transmission prior to application.
   e. Material is a vapor barrier after cure.
   f. Minimum age of concrete before application is 21-28 days, depending on curing and drying conditions.
   g. Thickness is excess of 2-in. is not recommended in areas exposed to thermal change.
   h. Maximum thickness of 12-in./lift for interior applications.

G. Resin Type G:

1. As a structural adhesive - Apply the neat mixed compound to the prepared substrates. Work into the substrate for positive adhesion. Secure the bonded unit firmly into place until the adhesive has cured. Glue line should be kept as thin as possible, not to exceed 3-in.
2. To seal injection ports and cracks for injection grouting - Place the neat mixed material over the cracks to be pressure-injected and around each injection port. Allow sufficient time to set before pressure-injecting.
3. To anchor bolts, dowels, and pins - Annular space around bolt should not exceed 1/8-in.; depth of embedment is typically 15 times the bolt diameter. Grout with neat compound.
4. To grout cracks - Use automated injecting equipment or manual method. Set appropriate injection ports based on the system used. Cracks up to 3-in. wide may be grouted.
5. To seal base plates and bearing pads - Inject in-place base plate or bearing pads with compound up to 3-in. thick. Consult manufacturer's instructions for additional information.
6. Limitations:
   a. Minimum surface temperature 40°F.
   b. Do not thin. Solvents will prevent proper cure.
   c. Material is a vapor barrier after cure.
   d. Not for sealing cracks under hydrostatic pressure.

PART 4 - MEASUREMENT AND PAYMENTS

4.1 GENERAL

A. No separate measurement or payment will be made for work required under this Section. All costs in connection therewith shall be considered incidental to the item or items of work to which the epoxy compound pertains.

END OF SECTION

SECTION 04800

MASONRY

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies the following items.

1. Concrete masonry units.
2. Face brick.
3. Stone trim units.
4. Mortar and grout.
5. Reinforcing steel, masonry joint reinforcement, ties and anchors
6. Masonry-cell insulation.
7. Cavity-wall insulation.

B. Items To Be Installed Only: Install the following items as furnished by the designated Sections:

1. Section 05500 MISCELLANEOUS METALS:

   a. Lintels, miscellaneous metal and iron sleeves, anchors, inserts and plates to be built into masonry walls.

2. Section 06100 ROUGH CARPENTRY:

   a. Wood nailers and blocking built into masonry.

3. Section 07600 FLASHING AND SHEET METAL:

   a. Through-wall flashings and built-in flashings.

4. Section 10440 SIGNS:

   a. Anchors and inserts for signage.
   b. .

5. Division 16 - ELECTRICAL:

   a. Access doors in masonry openings.

C. Items To Be Furnished Only: Furnish the following items for installation by the designated Sections:

1. Section 03300 - CAST-IN-PLACE CONCRETE:

   a. Dovetail slots for masonry anchors.

2. Section 05100 - STRUCTURAL STEEL:

   a. Anchor sections of adjustable masonry anchors for connecting to structural frame.

D. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 07920 - JOINT SEALANTS; sealing control and expansion joints in unit masonry.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Stone Trim Units: Show sizes, profiles, and locations of each stone trim unit required.
3. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement."

C. Samples for Verification: For each type and color of the following:

1. Exposed concrete masonry units.
2. Face brick, in the form of straps of five or more bricks.
3. Pigmented mortar. Make Samples using same sand and mortar ingredients to be used on Project. Label Samples to indicate types and amounts of pigments used.
4. Stone trim.
5. Weep holes/vents.
6. Accessories embedded in masonry.

D. Qualification Data: For testing agency.

E. Material Certificates: Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards. Provide for each type and size of the following:

1. Masonry units.

   a. Include material test reports substantiating compliance with requirements.
   b. For bricks, include size-variation data verifying that actual range of sizes falls within specified tolerances.
   c. For exposed brick, include material test report for efflorescence according to ASTM C 67.
   d. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.

2. Cementitious materials. Include brand, type, and name of manufacturer.
3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
4. Grout mixes. Include description of type and proportions of ingredients.

5. Reinforcing bars.
6. Joint reinforcement.
7. Anchors, ties, and metal accessories.

F. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports, per ASTM C 780 for mortar mixes required to comply with property specification.
2. Include test reports, per ASTM C 1019 for grout mixes required to comply with compressive strength requirement.

G. Tests Results: For each type of test including mortar, grout and prism tests, for approval by the Engineer.

H. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

I. UL Certificate of Compliance for fire rated concrete masonry units.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1093 for testing indicated, as documented according to ASTM E 548.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate.

D. Preconstruction Testing Service: The Contractor will engage a qualified independent testing agency to perform preconstruction testing indicated below. Payment for these services will be made by the Contractor. Retesting of materials that fail to meet specified requirements shall be done at Contractor's expense.

1. Prism Test: For each type of construction required, per ASTM C 1314; strength as specified.

E. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to authorities having jurisdiction. All fire rated Concrete Masonry Units shall meet the requirements of UL-618, Standards of Concrete Masonry Units. Concrete Masonry Units to be used for the construction of 2-Hour, 3-Hour and 4-Hour Fire Rated Walls shall be clearly marked by manufacturer. The manufacturer shall clearly mark all concrete masonry units in each cube with the appropriated UL designation of 2-Hour, 3-Hour or 4-Hour.

F. Hold Point - Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects. Comply with requirements in Division 1 for mockups.

1. Build sample panels for typical exterior and interior walls in sizes approximately 48 inches long by 48 inches high by full thickness.
2. Where masonry is to match existing, erect panels adjacent and parallel to existing surface.
3. Clean one-half of exposed faces of panels with masonry cleaner indicated.
4. Protect approved sample panels from the elements with weather-resistant membrane.
5. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Engineer in writing.

    a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless such deviations are specifically approved by Engineer in writing.

    b. The standard for the work during construction shall be the same as demonstrated on approved panels.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.5 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.

2. Where 1 wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 CONCRETE MASONRY UNITS (CMUs)

A. Concrete Masonry Units: ASTM C 90, normal weight unless indicated otherwise manufactured to dimensions 3/8 inch less than nominal dimensions.

B. Shapes: Provide standard shapes indicated and as required for building configuration. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

C. Integral Water Repellent: Provide units made with integral water repellent for exposed units.

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive according to ASTM E 514, with test period extended to 24 hours, show no visible water or leaks on the back of test specimen. Available products include:

a. Addiment Incorporated; Block Plus W-10.
b. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Dry-Block.
c. Master Builders, Inc.; Rheopel.

2.2 BRICK

A. Face Brick: ASTM C 216, Grade SW, Type FBS.

1. Trade Reference and Color: As selected by Engineer.
2. Size (Actual Dimensions): As selected by Engineer.
3. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested per ASTM C 67.
4. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced".
5. Where shown to "match existing", provide face brick matching color range, texture, and size of existing adjacent brickwork.

B. Building (Common) Brick where Concealed: ASTM C 62, Grade SW.

C. General: Provide shapes indicated and as follows:

1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces.
4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
5. Units which are sawn and less than one-half full size shall not be used.

2.3 STONE TRIM UNITS

A. Granite: Provide granite complying with ASTM C 615 and NBGQA's "Specifications for Architectural Granite" and as follows:

1. Varieties, Cut and Finish: As selected by Engineer.

B. Limestone: Provide limestone complying with ASTM C 568 and ILI's "Indiana Limestone Handbook" and as follows:

1. Varieties, Cut and Finish: As selected by Engineer.

C. Provide stone units accurately shaped, with exposed faces dressed true, and with beds and joints at right angles to faces.

1. For granite, comply with recommendations in NBGQA's "Specifications for Architectural Granite".

2. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook".

2.4 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S.

C. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Available Products:

   a. Bayer Corporation, Industrial Chemicals Div.; Bayferrox Iron Oxide Pigments.
   b. Davis Colors; True Tone Mortar Colors.
   c. Solomon Grind-Chem Services, Inc.; SGS Mortar Colors.

D. Aggregate for Mortar: ASTM C 144. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.

E. Aggregate for Grout: ASTM C 404.

F. Water: Potable.

2.5 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

B. Masonry Joint Reinforcement, General: ASTM A 951.

1. Interior Walls: Mill-galvanized, carbon steel.
2. Exterior Walls: Hot-dip galvanized, carbon steel.
3. Wire Size and Spacing: As required by Code.
4. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Multiwythe Masonry:

1. Ladder type with 1 side rod at each face shell of hollow masonry units more than 4 inches in width, plus 1 side rod at each wythe of masonry 4 inches or less in width.

2.6 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in subsequent paragraphs that are made from materials that comply with subparagraphs below, unless otherwise indicated.

1. Mill-Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 641/A 641M, Class 1 coating.
2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.
3. Stainless-Steel Wire: ASTM A 580/A 580M, Type 316.
4. Galvanized Steel Sheet: ASTM A 653/A 653M, Commercial Steel, G60 zinc coating.
5. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
6. Stainless Steel bars: ASTM A 276 or ASTM A 666, Type 304.

B. Adjustable Anchors for Connecting to Structure: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch-diameter, hot-dip galvanized steel. Mill-galvanized wire may be used at interior walls, unless otherwise indicated.

C. Partition Top Anchors: 0.097-inch-thick metal plate with 3/8-inch-diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.

D. Stone Anchors: Fabricate dowels, cramps, and other stone anchors from stainless steel.

E. Adjustable Masonry-Veneer Anchors:

1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, with structural performance capable of withstanding a 100-lb of load in both tension and compression without deforming or developing play in excess of 0.05 inch. Flat metal anchors are not acceptable.
2. Contractor's Option: Unless otherwise indicated, provide any of the following types of anchors.
3. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section.

    a. Anchor Section: Zinc-alloy barrel section with flanged head with eye and corrosion-resistant, self-drilling screw. Eye designed to receive wire tie and to serve as head for drilling fastener into framing. Barrel length to suit sheathing thickness, allowing screw to seat directly against framing with flanged head covering hole in sheathing.
    b. Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.188-inch-diameter, hot-dip galvanized steel wire.

2.7 MISCELLANEOUS ANCHORS

A. Anchor Bolts: L-shaped steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

2.8 EMBEDDED FLASHING MATERIALS

A. Metal Flashings: Furnished under Section 07620.

2.9 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Weep/Vent Products: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch less than depth of outer wythe; in color selected from manufacturer's standard.

E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity. Provide strips, full-depth of cavity and 10 inches wide, with dovetail shaped notches 7 inches deep that prevent mesh from being clogged with mortar droppings or equivalent. Available products:

1. Advanced Building Products Inc.; Mortar Break II.
2. Archovations, Inc.; CavClear Masonry Mat.
3. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
4. Mortar Net USA, Ltd.; Mortar Net.

2.10 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Available Manufacturers:

   a. Diedrich Technologies, Inc.
   b. EaCo Chem, Inc.
   c. ProSoCo, Inc.

2.11 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Limit cementitious materials in mortar to Portland cement [mortar cement] and lime.

B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.

1. For masonry below grade or in contact with earth, use Type M, minimum strength 2,500 psi.
2. For reinforced masonry, use Type S, minimum strength 1,800 psi.
3. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N, minimum strength 75 psi.

C. Pigmented Mortar: Use colored cement product. Pigments shall not exceed 10 percent of Portland cement by weight.

D. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
2. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
2. Verify that foundations are within tolerances specified.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed. Do not use units cut to less than one-half size.

E. Do not install concrete masonry units with more than 5 percent damage to the face. Do not install brick units which will show defects after installation.

F. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

G. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

H. Comply with construction tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:

1. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
2. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
3. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
4. For exposed bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch. Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
5. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
6. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

I. Do not retemper mortar.

3.3 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in bond pattern indicated on Drawings; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs. Prior to installation review bond pattern with Engineer.

C. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

D. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

E. Fill space between steel frames and masonry solidly with mortar, unless otherwise indicated.

F. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

G. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above, unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c., unless otherwise indicated.
3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Division 7 Section "Firestopping".

3.4 MORTAR BEDDING AND JOINTING

A. Lay hollow brick and concrete masonry units as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Set stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
2. Allow cleaned surfaces to dry before setting.

D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.

E. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint), unless otherwise indicated.

3.5 CAVITY WALLS

A. Bond wythes of cavity walls together using one of the following methods:

1. Masonry Joint Reinforcement: Installed in horizontal mortar joints. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.
2. Masonry Veneer Anchors: Comply with requirements for anchoring masonry veneers.

B. Bond wythes of cavity walls together using bonding system indicated on Drawings.

C. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

D. Coordinate and allow access for air and vapor barrier membrane and insulation installed in cavity under Section 07190 - Air and Vapor Barrier System.

3.6 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches. Space reinforcement not more than 16 inches o.c.

B. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

3.7 ANCHORING MASONRY TO STRUCTURAL MEMBERS

A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:

1. Provide an open space not less than 1 inch in width between masonry and structural member, unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry to structural members with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.8 ANCHORING MASONRY VENEERS

A. Anchor masonry veneers with masonry-veneer anchors to comply with the following requirements:

1. Fasten screw-attached anchors through insulation and sheathing to wall framing and to concrete and masonry backup as applicable with metal fasteners of type indicated.
2. Embed tie sections in masonry joints. Provide air space indicated on the Drawings between back of masonry veneer and face of insulation.
3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
4. Space anchors as required by Code.

3.9 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry using one of the following methods:

1. Fit bond-breaker strips into hollow contour in ends of concrete masonry units on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
2. Install preformed control-joint gaskets designed to fit standard sash block.
3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

C. Form expansion joints in brick made from clay or shale as follows:

1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
2. Build flanges of factory-fabricated, expansion-joint units into masonry.
3. Build in compressible joint fillers where indicated.
4. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Division 7 Section "Joint Sealants".

D. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 7 Section "Joint Sealants", but not less than 3/8 inch.

1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.10 LINTELS

A. Install steel lintels where indicated.

B. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

3.11 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

B. Install flashing as follows, unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
2. At multiwythe masonry walls, including cavity walls, extend flashing through outer Wythe, turned up a minimum of 8 inches, and 1-1/2 inches into the inner wythe. Form 1/4-inch hook in edge of flashing embedded in inner wythe.
3. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 8 inches; with upper edge covered with elastomeric membrane, lapping at least 4 inches.
4. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.

C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

D. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:

1. Use open head joints to form weep holes.
2. Space weep holes 24 inches o.c., unless otherwise indicated.

E. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 "Miscellaneous Masonry Accessories" Article.

F. Install vents in head joints in exterior wythes at spacing indicated.

3.12 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace,

tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.

2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

3.13 FIELD QUALITY CONTROL

A. Inspectors: The Contractor shall engage qualified independent inspectors to perform inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform inspections. Place grout only after inspectors have verified compliance of grout spaces and grades, sizes, and locations of reinforcement.

B. Testing Agency: The Contractor shall engage a qualified independent testing and inspecting agency to perform field tests and inspections indicated below and prepare test reports. Retesting of materials failing to comply with specified requirements shall be done at Contractor's expense.

C. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof. Test types as determined by the independent testing and inspection agency.

3.14 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Engineer's approval of sample cleaning before proceeding with cleaning of masonry.

3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.
7. Clean stone trim to comply with stone supplier's written instructions.

3.15 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than 4 inches in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Division 2 Section "Earthwork".
3. Do not dispose of masonry waste as fill within 18 inches of finished grade.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off the Site.

PART 4 - MEASUREMENT AND PAYMENT

4.1 PAYMENT

A. Payment for masonry will be made at the Contract unit prices for the quantities as specified above.

B. All work associated with masonry will be paid at the Contract Lump Sum Price Bid for Item 0613.019 – Access Platform which price shall include all costs associated with the furnishing and installing of all masonry items as shown on the Contract Documents, including all design, shop drawings, submittals, equipment, materials, reinforcing steel, inserts, bearing pads, labor, transportation, and incidentals required to perform the work to the satisfaction of the Engineer.

4.2 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0613.019	ACCESS PLATFORM	LS

END OF SECTION

SECTION 05041

HOT-DIP GALVANIZING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies Hot-Dip Galvanizing for all miscellaneous steel, architecturally exposed steel, and structural steel that is exposed to view, the weather, moisture, or corrosive atmosphere. Such items shall include but are not limited to:
   1. Structural steel items specified in Section 05100 – Structural Steel
   2. Structural steel items specified in Section 05500 – Miscellaneous Metals

B. Definition of Hot-Dip Galvanizing: The dipping of steel members and assemblies into an alloy of molten zinc and nickel for lasting long-term protection. The resultant nickel zinc alloys with the base metal.

1.2 RELATED WORK

A. Carefully examine all of the Contract Documents for requirements which affect the work of this section.

B. Other specification sections which directly relate to the work of this section include, but are not limited to, the following:
   1. Section 05100 – STRUCTURAL STEEL
   2. Section 05500 – MISCELLANEOUS METALS

1.3 QUALITY ASSURANCE

A. Reference Standard:

   1. American Hot-Dip Galvanizers Association, Inc., (AHDGA):

      Publication entitled "Inspection Manual for Hot-Dip Galvanized Products.

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

      A 123 – Zinc Coating (Hot-Dip) on Iron and Steel Hardware

      A 143 – Safeguarding Against Embrittlement

      A 384 – Safeguarding Against Warpage

      A 385 – Providing High Quality Zinc Coatings

      A 780 – Repair of Hot-Dip Galvanizing

1.4 SUBMITTALS

A. Certification: Furnish Notarized Certificates of Compliance with ASTM Standards and Specifications herein listed. Each Certificate to be signed by the Galvanizer and shall list a detailed description of all material. Certification shall state that the galvanizing is in full conformance with these specifications.

B. Visual Stamp: Mark all lots of material with a clearly visible tag indicating the name of the galvanizer, the weight of the nickel – the coating and the applicable ASTM Specification numbers.

C. Product Data: Submit product literature and sample for organic zinc rich repair compounds to be used.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Packaging: Of a suitable type to prevent damage to the finished surface and to prevent shipping damage to the material.

B. Handling and Storage: Handle and Store in such a manner as to minimize damage to the finished material.

PART 2 - PRODUCTS

3.1 STEEL MATERIALS

A. Material for galvanizing shall be geometrically suitable for galvanizing as specified in ASTM A-384 and A-385.

B. To be chemically suitable for galvanizing, steel shall contain carbon below 0.25%; phosphorous below 0.05%; manganese below 1.35%.

3.2 NICKEL-ZINC FOR GALVANIZING

A. Conform to ASTM B-6, as specified in ASTM A123 only with the addition to the bath of a predetermined amount of nickel (not less than 0.05% by weight) to counter the affect of high silicon steel.

3.3 GALVANIZING

A. Steel members, fabrications, and assemblies as identified in Section 1.1A shall be galvanized after fabrication in accordance with ASTM A123.

B. Safeguard against embrittlement in conformance with ASTM A143.

C. To safeguard against warpage or distortion of steel members, in conformance with ASTM A384, submit shop drawings of non-standard fabrications, all tubular fabrications, all fabrications involving materials of different thicknesses. Submit drawings to the galvanizer prior to fabrication to determine the suitability of the material for galvanizing.

1. Note on shop drawings locations of "blow holes" so that they can be drilled prior to galvanizing.

D. Weight of Coating: Weight of all zinc coating shall be 2.0 ounces per sq. ft. minimum.

E. Galvanizing Application: Galvanize materials in accordance with specified standards and this Specification. Galvanizing shall provide an acceptable substrate for applied coatings. After pickling and prior to galvanizing, the steel shall be immersed in a bath of zinc ammonium chloride. The dry kettle process shall be used to eliminate any flux inclusions on the surface of the galvanized material.

F. Galvanizing shall be performed under conditions so that "White Rust" is avoided.

PART 3 - EXECUTION

3.1 INSTALLATION OF STEEL MATERIALS

A. Steel materials, fabrications, and assemblies are specified to be installed in various other sections under Division 05, METALS.

3.2 TOUCH-UP AND REPAIR

A. Repair damaged and field welded galvanized surface in accordance with ASTM A780.

B. Dry film thickness of the organic zinc rich repair compound shall not be less than 6 mils.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

A. Separate measurement and payment will not be made for all work required under this Section, but all costs in connection therefore will be considered incidental to the item of work to which it pertains.

END OF SECTION

SECTION 05100

STRUCTURAL STEEL

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies the following items.

1. Structural steel.
2. Miscellaneous structural steel repairs at Sudbury River Bridge (M.P. 20.48) and Mill Pond Bridge (M.P. 40.01).
3. Removal of existing rivets and replacement with high strength bolts at Sudbury River Bridge (M.P. 20.48) and Mill Pond Bridge (M.P. 40.01).
4. Structural steel for station canopy structures, roof structures, ramps, overpass, and other station elements.
5. Steel piles for soldier pile excavation support.
6. Support frames for the prefabricated maintenance building.
7. Architecturally exposed structural steel.

B. Items To Be Installed Only: Install the following items as furnished by the designated Sections:

1. Section 04800 - MASONRY: Anchor sections of adjustable masonry anchors for connecting to structural frame.

C. Items To Be Furnished Only: Furnish the following items for installation by the designated Sections

1. Section 03300 - CAST-IN-PLACE CONCRETE: Lintels, sleeves, anchors, inserts, embedded wall plates, loose leveling plates, and similar items.

D. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 02090 – LEAD-BASED PAINT ABATEMENT
2. Section 03300 – CAST-IN-PLACE CONCRETE
3. Section 03410 – PLANT-PRECAST STRUCTURAL CONCRETE
4. Section 05041 – HOT-DIP GALVANIZING
5. Section 03254 – ELASTOMERIC BEARING PADS
6. Section 05310 – STEEL DECK
7. Section 05500 – MISCELLANEOUS METAL
8. Section 07411 – PREFORMED METAL CANOPY SYSTEM
9. Section 09900 – PAINTING
10. Section 13100 – PREFABRICATED STRUCTURES

1.2 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges", that support design loads.

B. Architectural Exposed Structural Steel: Structural steel that forms and prominent architectural feature in a building or structure or designated at architecturally exposed structural steel on the Contract Drawings.

1.3 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of connections required by the Contract Documents to be selected or completed by the structural-steel fabricator to withstand loads indicated and comply with other information and restrictions indicated.

1. Select and complete connections using the American Institute of Steel Construction's (AISC) "Manual of Steel Construction, Load and Resistance Factor Design", Volume 2, Part 9.
2. Engineering Responsibility: Fabricator's responsibilities include using a qualified professional engineer to prepare structural analysis data for structural-steel connections.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length and type of each weld.
4. Indicate type, size and length of bolts, distinguishing between shop and field bolts. Identify pre-tensioned and slip-critical high-strength bolted connections.
5. For structural-steel connections indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Welding Certificates: Certificate from AWS indicating certification in type of welding required for each welder and welding operator.

D. Welding Records and Data:

1. Before welding, submit the procedure which will be used for qualifying welders and welding procedures. For procedures other than those pre-qualified in accordance with AWS D1.1, submit a copy of procedure qualification test records.
2. Submit certified copy of qualification test records for each welder, welding operator, and tacker who will be employed in the work.
3. If field welding is permitted, submit descriptive data for field welding equipment.
4. Submit all NDE records (radiographs, ultrasonic, magnetic particle) and visual inspection reports upon completion or when otherwise requested by the Engineer.

E. Qualification Data: For installer, fabricator, professional engineer, testing agency, welding inspectors, NDE inspectors and galvanizer. Submit prior to starting work.

F. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements:

1. Structural steel including chemical and physical properties.
2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
3. Direct-tension indicators.
4. Tension-control, high-strength bolt-nut-washer assemblies.
5. Shear stud connectors.
6. Shop primers.
7. Nonshrink grout.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is certified for: Steel Building Structures (STD); or Simple Steel Bridge Structures (SBD); or Major Steel Bridges (CBR) as applicable

B. Galvanizer Qualifications: Engage the services of a qualified galvanizer who has demonstrated a minimum of five years experience in the successful application of galvanized coatings specified in this Section in the facility where the work is to be performed and who will apply the coatings within the same facility.

C. Installer Qualifications: A qualified installer with previous experience in installing structural steel.

D. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel"

1. Welds shall be made only by welders, welding operators and track welders who have been previously qualified by tests as prescribed by AWS D1.5 and AWS D1.1 to perform the type of work required. Certification shall be provided by the fabricator for each welder, welding operator and track welder involved that has been thus qualified within the previous 12 months.
2. The AWS D1.5 shall be used for all requirements not specifically covered herein.
3. Welding of Fracture Critical Members shall be in accordance with the requirements of Section 1.14 of AREMA Chapter 15.

E. Comply with applicable provisions of the following specifications and documents:

1. AISC's "Code of Standard Practice for Steel Buildings and Bridges"
2. AISC's "Seismic Provisions for Structural Steel Buildings" and "Supplement No. 2"
3. AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design" and "Load and Resistance Factor Design Specification for Structural Steel Buildings"
4. AISC's "Specification for the Design of Steel Hollow Structural Sections"
5. AISC's "Specification for Allowable Stress Design of Single-Angle Members" and "Specification for Load and Resistance Factor Design of Single-Angle Members"
6. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts"
7. Welding fabrication for structures designed in accordance with AASHTO and AREMA shall be fabricated in accordance with the Bridge Welding Code, ANSI/AASHTO/AWS 1.5 including all interim revisions published by AASHTO as of the opening bid date.

F. Tests and Inspection

1. The Contractor will test and inspect high-strength bolted connections and welded connections and prepare test reports. Specialty tests shall be performed at no expense to the Authority by an independent testing laboratory approved by the Engineer. Costs of specialty tests shall be borne by the Contractor. Test reports shall be submitted to the Engineer for approval.

2. The Engineer reserves the right to inspect high-strength bolted connections and weld connections. Provide access to places where structural steel work is being fabricated or erected so that required inspection and testing can be accomplished at no change in Contract Price. At times, inspection may require moving or handling of steel to permit proper inspection. Notify Materials Testing Laboratory not less than 48 hours prior to start of fabrication.
3. The Engineer may inspect structural steel at the plant before shipment; however, the Engineer reserves the right, at any time before final acceptance, to reject material not complying with specified requirements.
4. Correct deficiencies in structural steel work that inspections and laboratory test reports have indicated to be not in compliance with requirements at the Contractor's expense. Perform additional tests, at no expense to the Authority, as may be necessary to reconfirm any non-compliance of the original work, and as may be necessary to show compliance of corrected work.
5. Specialty Tests: Nondestructive examination of welds in accordance with provisions of AWS D1.1 and ASTM Standards noted shall be made in accordance with the following schedule:
   a. Radiographic Examination of Welds, per ASTM E94 and E142:
      1. Field, complete joint penetration groove welds:
         a. 1 out of 5 (20 percent) with thickness equal to or less than 3/4 inch.
         b. 100 percent with thickness greater than 3/4 inch.
      2. Shop, complete joint penetration groove welds:
         a. 1 out of 10 (10 percent) with thickness equal to or less than 3/4 inch.
         b. 1 out of 2 (50 percent) with thickness greater than 3/4 inch and equal to or less than 1-1/2 inches.
         c. 100 percent for thickness greater than 1-1/2 inches.
   a. Ultrasonic Examination, per ASTM E164: Complete joint penetration groove butt welds not accessible for radiographic examination shall be subjected to ultrasonic testing. The extent shall be the same as noted for radiographic examination. Ultrasonic examination shall be made 48 to 72 hours after welding at locations on weldments or welded joints subject to high restraint as indicated in order to check for lameller tearing. The exact location of the areas to be inspected shall be determined with the Engineer at the time of fabrication. This examination shall be made according to the following schedule unless conditions of tearing require a greater number of tests, as directed:
      1. 1 out of 10 (10 percent) for thickness equal to or less than 3/4 inch.
      2. 1 out of 5 (20 percent) for thickness greater than 3/4 inch and equal to or less than 1-1/4 inches.
      3. 1 out of 2 (50 percent) for thickness greater than 1-1/4 inches.
   b. Magnetic Particle Examination, per ASTM E709, field and shop:
      1. 1 out of 5 (20 percent) of complete joint penetration groove welds of tee and corner joints.
      2. 1 out of 10 (10 percent) of partial joint penetration groove and fillet welds.
   c. penetrant Examination, per ASTM E165: Shall be used for detecting discontinuities that are open to the surface use as appropriate.
   d. Specialty tests shall be performed at no expense to the Authority by an independent testing laboratory approved by the engineer. The independent testing laboratory shall maintain inspections for this work that possess certification as Certified Welding Inspectors in accordance with the provisions of AWS QCI Standard and Guide for Qualification and Certification of Welding Inspectors. Notify the Engineer not less than 48 hours prior to conducting special test. Costs of specialty test shall be borne by the contractor. Test reports shall be submitted to the Engineer for approval.
6. Visual Examination: All welds whether otherwise examined or not shall be visually examined and faulty joints shall be marked for correction.

7. When any testing, examination or inspection reveals faulty welds, all joints of the same type shall be checked at no expense to the Authority until the integrity of the weld is assured before resuming examination.
8. After faulty welds have been corrected or repaired, they shall each be re-examined at no expense to the Authority in the manner specified for the original joint.
9. It is intended that inspections shall be performed to permit an orderly flow of completed material from the shop. Work with the Engineer to establish a schedule that will permit this.
10. Test result information shall be forwarded to the Engineer immediately after test results are available stating the acceptance or rejection of fabricated pieces in order that the repairs and re-inspection may be made as soon as possible.

G. Pre-Installation Conference: Contractor shall schedule a meeting to be attended by Contractor, Engineer, fabricator and galvanizer. Agenda shall include the following: Project schedule, source for each fabrication, coordination between fabricator and galvanizer and adjacent Work, finish of surfaces, application of coatings, submittals, and approvals.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.

1. Store fasteners in a protected place. Clean and re-lubricate bolts and nuts that become dry or rusty before use.
2. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.7 COORDINATION

A. Furnish anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions and directions for installation.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. Channels, Angles, M-Shapes, S-Shapes, W-Shapes: ASTM A 572, Grade 50.

B. Plate and Bar: ASTM A 572/A 572M, Grade 50.

C. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.

D. Steel Pipe: ASTM A 53, Type E or S, Grade B.

E. Medium-Strength Steel Castings: ASTM A 27, Grade 65-35 carbon steel.

F. High-Strength Steel Castings: ASTM A 148,Grade 80-50, carbon or alloy steel.

G. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.

1. Finish: Hot-dip zinc coating, ASTM A 153, Class C.

B. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, steel structural bolts with splined ends; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers. Finish, mechanically deposited zinc coating, ASTM B 695, Class 50.

C. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.

D. Anchor Rods: ASTM F 1554, grade as applicable, hot-dip zinc coating, ASTM A 153, Class C.

E. Threaded Rods: ASTM A 193, grade as applicable, hot-dip zinc coating, ASTM A 153, Class C.

F. Eye Bolts and Nuts: ASTM A 108, Grade 1030, cold-finished carbon steel.

G. Sleeve Nuts: ASTM A 108, Grade 1018, cold-finished carbon steel.

2.3 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: Coatings meeting requirements of ASTM A 780.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.4 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AREMA Manual for Railway Engineering Chapter 15 Steel Structures and AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design".

1. Camber structural-steel members where indicated.
2. Identify high-strength structural steel according to ASTM A 6/ A 6M and maintain markings until structural steel has been erected.
3. Mark and match-mark materials for field assembly.
4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

F. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
2. Base-Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.5 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work. Complete welds in accordance with the Contract Drawings.

1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
3. Insufficient welds shall be rejected and corrected until required profiles are met.
4. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.
   a. Grind butt welds flush.
   b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.
5. No skip welds will be permitted for steel connections to be coated.

2.6 STEEL PRIMERS AND FINISHES

A. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for The Society for Protective Coatings (SSPC) surface preparation specifications and environmental exposure conditions of installed metal fabrications:

1. Exteriors (SSPC Zone 1B) and Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 10/NACE No. 2, "Near White Metal Blast Cleaning"
2. Interiors (SSPC Zone 1A): SSPC-SP 6, "Commercial Blast Cleaning"
3. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be field welded, embedded in concrete or masonry, unless otherwise indicated. Extend priming of partially embedded members to a depth of 2 inches.
4. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel" for shop painting.
5. Comply with SSPC-PA 2, "Measurement of Dry Coating Thickness with magnetic Gages"

B. Zinc-Rich Primer: Urethane zinc rich primer compatible with topcoat Specified in Section 09900. Provide primer with a VOC content of 340 g/L (2.8 lb/gal.) or less per OTC ozone standards. Provide Tnemec Series 394 or Ameron 5105 or equal by DuPont or Carboline for exposed steel to be fireproofed, or Tnemec Series 901K97 Series or 90-97 or Ameron 68HS or equal by DuPont or Carboline for exposed steel to be finish painted at 3.0 mils DFT.

C. Primer for Exposed Steel to Receive Multi-Coat Shop-Applied Coating: Tnemec Series 901K97 or 90-97 urethane zinc rich primer at 3.0 to 3.5 mils DFT, topcoated in shop with Tnemec Series V73 Endura-Shield, or use Ameron Series 68HS Primer at 3.0 to 5.0 mils DFT topcoated in shop with Ameron's Amercoat 450H, or use or equal primers and finish coats from DuPont or Carboline.

D. Galvanizing: For steel exposed to the elements, weather or corrosive environments and other steel indicated to be galvanized, provide coating for iron and steel fabrications applied by the hot-dip process. Comply with ASTM A 123 for fabricated products and ASTM A 153 for hardware. Provide thickness of galvanizing specified in referenced standards. The galvanizing bath shall contain high grade zinc and other earthly materials. Fill vent holes and grind smooth after galvanizing.

E. Hot-Dip Galvanizing And Factory-Applied Primer for Steel: Provide hot-dip galvanizing and factory-applied prime coat, certified OTC/VOC compliant less than 2.8 lbs/gal. and conforming to EPA and Commonwealth of Massachusetts requirements. Apply primer within 12 hours after galvanizing at the galvanizer's plant in a controlled environment meeting applicable environmental regulations and as recommended by the primer coating manufacturer. Blast cleaning of the surface is unacceptable for surface preparation. Primer shall have a minimum two year re-coat window for application of finish coat. Coatings must meet or exceed the following performance criteria:

1. Abrasion: ASTM D 4060, CS17 Wheel, 1,000 gram load.
2. Adhesion: ASTM D 3359, Method B, 5 mm crosshatch.
3. Humidity Resistance: ASTM D 4585.
4. Salt Spray (Fog): ASTM B 117.

F. Hot-Dip Galvanizing and Factory-Applied Urethane Primer and Finish for Steel: Provide factory-applied architectural coating over primed hot-dip galvanized steel matching approved samples.

1. Primer coat shall be factory-applied polyamide epoxy primer. Apply primer within 12 hours after galvanizing at the galvanizer's plant in a controlled environment meeting applicable environmental regulations and as recommended by the primer coating manufacturer.
2. Finish coat shall be factory-applied color-pigmented architectural finish. Apply finish coating at the galvanizer's plant, in a controlled environment meeting applicable environmental regulations and as recommended by the finish coating manufacturer.
3. Coatings shall be certified OTC/VOC compliant and conform to applicable regulations and EPA standards.
4. Apply the galvanizing, primer and coating within the same facility and provide single-source responsibility for galvanizing, priming and finish coating.
5. Blast cleaning of the galvanized surface is not acceptable.
6. Primer shall meet or exceed the following performance criteria:
   a. Abrasion: ASTM D 4060, CS17 Wheel, 1,000 gram load.
   b. Adhesion: ASTM D 3359, Method B, 5 mm crosshatch.
7. Humidity Resistance: ASTM D 4585.
8. Salt Spray (Fog): ASTM B 117.
9. Finish coat shall meet or exceed the following performance criteria:
   a. Abrasion: ASTM D 4060, CS17 Wheel, 1,000 gram load.
   b. Adhesion: ASTM D 3359, Method B, 5 mm crosshatch.

c. Graffiti Resistance: After drying for seven days, no staining from acrylic, epoxy, epoxy-ester and alkyd spray paints, ballpoint pen, crayons, magic marker, black shoe polish and lipstick.
d. Weathering: ASTM D 1014, 45 degrees facing south.
e. Surface Burning Characteristics: ASTM E 84
f. QUV: ASTM G53, ES-40 bulbs, 4 hours light, 4 hours dark.
g. Salt Spray (Fog): ASTM B 117.

2. Clearcoat over finish coat shall meet or exceed the following performance criteria:
   a. Abrasion: ASTM D 4060, CS17 Wheel, 1,000 gram load.
   b. Adhesion: ASTM D 3359, Method B, 5 mm crosshatch.
   c. Graffiti Resistance: After drying for seven days, no staining from acrylic, epoxy, epoxy-ester and alkyd spray paints, ballpoint pen, crayons, magic marker, black shoe polish and lipstick.
   d. Weathering: ASTM D 1014, 45 degrees facing south; and ASTM D 4141C EMMAQUA-NTW.
   e. QUV: ASTM G53, ES-40 bulbs, 4 hours light, 4 hours dark.
   f. Salt Spray (Fog): ASTM B 117.
   g. Flexibility: ASTM D 522, Method B, cylindrical mandrel.
   h. Hardness: ASTM D 3363 (Pencil).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements. Elevations shall be verified by a surveyor licensed in the Commonwealth of Massachusetts.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges".

B. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.

1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of base plate.
3. Snug-tighten or pretension anchor rods as applicable after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.
4. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

D. Maintain erection tolerances of structural steel and architecturally exposed structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges".

E. Splice members only where indicated.

F. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.

G. Do not use thermal cutting during erection unless approved by Engineer. Finish thermally cut sections within smoothness limits in AWS D1.1.

H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

I. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint indicated on the Drawings.

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.

1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

4. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.
   a. Grind butt welds flush.
   b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.
   c. Re-profile all steel surfaces (using needle guns or other profiling methods) that have been welded and ground smooth to assure proper adhesion of primers and topcoats.

5. No welding within the tension zone of members will be permitted except for attachment of shear connectors, as called for on the contract plans.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.

B. Bolted Connections: Bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts". When using bolted connections prime with "slip critical class B" primer as specified in this Section. All surfaces of bolted or bearing connections may be primed. When welding, hold back primer a minimum of 2 inches each side of weld.

C. Welded Connections: Field welds will be visually inspected according to AWS D1.1. In addition to visual inspection, specialty tests will be performed in accordance with AWS D1.1 and at the frequency stated in Article 1.5.F.5

D. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1 for stud welding and as follows:

1. Perform bend tests if visual inspections reveal either a less-than- continuous 360-degree flash or welding repairs to any shear connector.
2. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

E. Correct deficiencies in Work that test reports and inspections indicate do not comply with the Contract Documents.

3.6 REPAIRS AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, bearing plates, and abutting structural steel.

1. Clean and prepare surfaces by SSPC-SP 3 power-tool cleaning.
2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Only structural steel incorporated into the completed work will be measured for payment under this section. Temporary supports, jigs, jacking frames, blocking, or any other temporary device or structure which the Contractor finds necessary to safely construct the work will not be measured separately for payment.

B. Structural steel will be measured by the pound, calculated without deduction for holes under 12 inches longest dimension, for each item, and type, complete and in place, regardless of material grade. Measurement shall be based only on computed masses of steel complete in place in the structure. No additional allowance in mass shall be made for the shop coat of paint or any coat of paint or other protective coating. The mass of the rolled shapes and of the plates, regardless of the width of the plates, shall be computed on the basis of their nominal mass and of their dimensions as shown on the approved shop drawings, deducting for copes and cuts, and for all open holes that are not filled with rivets, bolts or plug welded.

C. Stud shear connectors affixed to steel will not be measured separately for payment, but all costs in connection therewith will be considered incidental to the applicable items of structural steel work.

D. Shims, wedges, fasteners, metallic coating, and setting bearing plates including dry packing, will not be measured separately for payment, but all costs in connection therewith will be considered incidental to the applicable items of structural steel work. Fasteners shall include the weight associated with the bolted connections, including all washers and nuts.

E. Miscellaneous Structural Steel Bridge Repairs will be measured by the pound, calculated without deduction for holes under 12 inches longest dimension, for each item, and type, complete and in place, regardless of material grade. Measurement shall be based only on computed masses of steel complete in place in the structure. No additional allowance in mass shall be made for the shop coat of paint or any coat of paint or other protective coating. The mass of the rolled shapes and of the plates, regardless of the width of the plates, shall be computed on the basis of their nominal mass and of their dimensions as shown on the approved shop drawings, deducting for copes and cuts, and for all open holes that are not filled with rivets, bolts or plug welded.

F. Drilling, welding, and all other work associated with connections and erection of structural steel and miscellaneous structural steel bridge repairs, whether performed in the shop or in the field will not be measured separately for payment, but all cost in connection therewith will be considered incidental to the work to which it pertains. Computed weights shall not include the weight of welds.

G. Removal of Rivets and Replacement with High Strength Bolts will be measured per each rivet removed, as directed by the Engineer.

H. Miscellaneous metals keeper plate assemblies will be measured per each bearing retainer plate installed at the Sudbury River Bridge (MP 20.48) complete in place.

I. Bridge Bearings will be measured per each bearing installed on the walkway structure at Baker's Brook Bridge (MP 47.84) complete in place.

J. Structural steel for the South Acton Station pedestrian overpass, ramps, and related station elements will not be measured separately, but shall be included in the Contract Lump Sum Item 0211.615 - Pedestrian

Overpass complete in place, including all steel, connections, accessories, incidentals, labor, tools, equipment and all other work required to complete the installation to the satisfaction of the Engineer.

K. Structural steel for the south Acton Station platform connections and other platform related elements will not be measured separately, but shall be included in the Contract Unit Price per Lump Sum for Item 0613.019 – Access Platform complete in place, including all steel, connections, accessories, incidentals, labor, tools, equipment and all other work required to complete the installation to the satisfaction of the Engineer.

L. Structural steel for south Acton Station canopy systems will not be measured separately, but shall be included in the Contract Unit Price per Square Foot for Item 0613.020 – Platform Canopy complete in place, including all steel, connections, accessories, incidentals, labor, tools, equipment and all other work required to complete the installation to the satisfaction of the Engineer.

M. Structural steel for Bench and Station Sign/Display Structures will not be measured separately, but shall be included in the Contract Unit Prices per Each for Item Nos. 1041.501 through 1041.505 – Station Sign Type A through Station Sign Type E, respectively, complete in place, including all steel, connections, accessories, incidentals, labor, tools, equipment and all other work required to complete the installation to the satisfaction of the Engineer.

N. Structural steel for prefabricated maintenance structure support framing will not be measured separately, but shall be included in the Contract Lump Sum Price for Item No. 1365.000 – Prefabricated Structures complete in place, including all steel, connections, accessories, incidentals, labor, tools, equipment and all other work required to complete the installation to the satisfaction of the Engineer.

O. Separate Measurement and Payment will not be made for all other Structural Steel complete in place, but all costs in connection therefore shall be included in the item or items of work to which they pertain.

4.2 PAYMENT

A. Payment for the items below will be made at the Contract unit price for the measurement as specified above.

B. Payment for Miscellaneous Structural Steel Bridge Repairs will be made at the Contract Unit Price Bid per pound for the quantities as specifies above. Payment shall constitute full compensation for removal and disposal of deteriorated steel and rivets, cutting, grinding, field measurements, furnishing structural steel, shop painting, field drilling, field bolting, transportation, labor, materials, equipment and incidentals necessary to complete the fabrication and erection of structural steel and repairs in accordance with the above described work and to the complete satisfaction of the Engineer.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
211.615	PEDESTRIAN OVERPASS	LS
0510.350	STRUCTURAL STEEL	LB
0510.362	MISC. STRUCTURAL STEEL BRIDGE REPAIRS	LB
0512.115	REMOVE RIVETS AND REPLACE WITH HIGH STRENGTH BOLTS	EA
0525.201	MISCELLANEOUS METALS KEEPER PLATE ASSEMBLY	EA
0526.000	BRIDGE BEARINGS	EA
0613.019	ACCESS PLATFORM	LS
0613.020	PLATFORM CANOPY	SF
1041.501	STATION SIGN – TYPE A	EA
1041.502	STATION SIGN – TYPE B	EA
1041.503	STATION SIGN – TYPE C	EA
1041.504	STATION SIGN – TYPE D	EA
1041.505	STATION SIGN – TYPE E	EA
1365.000	PREFABRICATED STRUCTURES	LS

END OF SECTION

SECTION 05500

MISCELLANEOUS METALS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies the following items.

1. All Work in this Section; refer to Schedule in Par. 2.1 and as indicated on the Drawings.

B. Work under this Section includes galvanized open steel grating walkways for the Assabet River Bridge (MP 21.76) and West Acton Bridge (MP 27.46) as indicated on the Contract Documents and specified herein.

C. Work under this Section includes galvanized and painted steel pipe railings for the Waltham Culvert (MP 8.65), Assabet River Bridge (MP 21.76) and West Acton Bridge (MP 27.46) as indicated on the Contract Documents and specified herein.

D. Work under this Section includes railings, supports, framing, gutters and downspouts, and other elements of the South Acton Station as indicated on the Contract Documents and specified herein.

E. Items To Be Furnished Only: Furnish the following items for installation by the designated Sections

1. Section 03300 - CAST-IN-PLACE CONCRETE.
   a. Lintels, sleeves, anchors, inserts, plates and similar items.

F. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 05100 - STRUCTURAL STEEL; structural steel items.

1.2 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F ambient; 180 deg F material surfaces.

1.3 SUBMITTALS

A. Product Data: For paint products.

B. Samples: Two three by six inch samples of shop-applied finishes, in color selected.

C. Shop Drawings: Show fabrication and installation details for metal fabrications.

1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
2. Provide templates for anchors and bolts specified for installation under other Sections.
3. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer licensed in the Commonwealth of Massachusetts responsible for their preparation.
4. Where fabrications are to receive sprayed-on fireproofing, include statement that primer is compatible with fireproofing proposed for use.

D. Certificates: Welder and weld procedure qualifications.

E. Qualifications for Inspection and Testing Agency and Contractor's professional engineer indicating registration in the Commonwealth of Massachusetts.

F. Weld inspection reports.

1.4 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel".
2. AWS D1.2, "Structural Welding Code--Aluminum".
3. AWS D1.3, "Structural Welding Code--Sheet Steel".
4. AWS D1.6, "Structural Welding Code--Stainless Steel".

B. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

C. Galvanizer Qualifications: Engage the services of a qualified galvanizer who has demonstrated a minimum of five years experience in the successful application of galvanized coatings specified in this Section in the facility where the work is to be performed and who will apply the coatings within the same facility.

D. Pre-Installation Conference: Contractor shall schedule a meeting to be attended by Contractor, Engineer, fabricator, and galvanizer prior to starting Work. Agenda shall include the following: Project schedule, source for each fabrication, coordination between fabricator and galvanizer and adjacent Work, finish of surfaces, application of coatings, submittals, and approvals.

E. Inspection. Except as otherwise specified, only visual inspection of welds, materials, workmanship, finished products, and installation is required.

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication and indicate measurements on Shop Drawings. Provide allowance for trimming and fitting at site.

1.6 COORDINATION

A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 SCHEDULE

A. Bridge Items - Metal fabrications include, but are not limited to, the following. Requirements for materials and coatings/finishes which are included as part of the Work specified in this Section are listed with each item.

	ITEM	MATERIAL	COATING/FINISH
1.	Exterior Handrails and Railings	Steel Stainless Steel	Galv/Primer/finish No. 4 finish
2.	Areaway Gratings	Steel	Galv
3.	Loose Bearing and Leveling Plates	Steel	Galv
4.	Shelf Angles	Steel	Gal/primer/finish

B. Station Items

	ITEM	MATERIAL	COATING/FINISH
1.	Exterior Handrails and Railings	Steel	Galv
2.	Exterior Ladders	Steel	Galv
3.	Metal Floor Plate	Steel	Galv
4.	Bollards	Steel	Galv
5.	Loose Bearing and Leveling Plates	Steel	Galv
6.	Weld Plates and Angles	Steel	Galv
7.	Areaway Gratings	Steel	Galv
8.	Supports for Canopies	Steel	Galv
9.	Supports for Roofs	Steel	Galv
10.	Pipe Guards	Steel	Galv
11.	Expanded Metal Sheet Paneling	Steel	Galv
12.	Electrical Conduits	Steel	Galv
13.	Display Frame Systems, Poster Cases	Steel	Galv
14.	Housing for VMS Signs	Steel	Galv
15.	Canopy Grating	Aluminum	Anodized
16.	Hoods at Lights	Aluminum	Anodized
17.	Hood at VMS Sign, Perforated	Aluminum	Anodized
18.	Snow Guards and Snow Tabs	Steel	Galv
19.	Gutters and Downspouts		
20.	Bench Supports		
21.	End of Platform Gates		

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 316L

C. Stainless-Steel Bars and Shapes: ASTM A 276, Type 316L

D. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

E. Steel Tubing: ASTM A 500, cold-formed steel tubing.

F. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.

G. Slotted Channel Framing: Cold-formed metal channels with continuous slot complying with Metal Framing Manufacturers Association MFMA-3.

H. Cast Iron: ASTM A 48/A 48M, Class 30, unless another class is indicated or required by structural loads.

I. Woven wire fabric: 1" x 1" flat top weave of 0.12" diameter pre-galvanized carbon steel wire.

2.3 NONFERROUS METALS

A. Aluminum Plate and Sheet: ASTM B 209, Alloy 6061-T6.

B. Aluminum Extrusions: ASTM B 221, Alloy 6063-T6.

C. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.

D. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

2.4 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, within exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.

B. Anchor Bolts: ASTM F 1554, Grade 36. Provide hot-dip or mechanically deposited, zinc-coated anchor bolts where item being fastened is indicated to be galvanized.

C. Cast-in-Place Anchors in Concrete: Anchors shall be capable of sustaining, without failure, a load equal to four times the load imposed. Tests shall be as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency. Threaded or wedge type; galvanized ferrous

castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A 153/A 153M.

D. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488. Tests shall be conducted by a qualified independent testing agency.

1. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
2. Material for Anchors in Exterior Locations: Stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with The Society for Protective Coatings SSPC-Paint 20 or ASTM A780.

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.6 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work true to line and level with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with 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 no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts, unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

2.7 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts if units are installed after concrete is placed.

C. Fabricate supports for operable partitions from continuous steel beams of sizes indicated with attached bearing plates, anchors, and braces as indicated. Drill bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.

2.8 LOOSE BEARING AND LEVELING PLATES

2.9 Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

2.10 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with not less than two integrally welded steel strap anchors for embedding in concrete.

2.11 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

2.12 METAL LADDERS

A. Provide metal ladders complying with ANSI A14.3. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted brackets, made from same metal as ladder. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.

2.13 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 40 steel pipe.

B. Fabricate bollards with 3/8-inch-thick steel baseplates for bolting to concrete slab. Drill baseplates at all 4 corners for 3/4-inch anchor bolts. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.

2.14 PIPE GUARDS

A. Fabricate pipe guards from 3/8-inch-thick by 12-inch wide steel plate, bent to fit flat against the wall or column at both ends and to fit around pipe with 2-inch clearance between pipe and pipe guard. Drill each end for two 3/4-inch anchor bolts.

2.15 METAL FLOOR PLATE

A. Fabricate from rolled-steel floor plate of minimum 1/4 inch steel unless thicker units are required for anticipated loadings.

B. Include steel angle stiffeners, and fixed and removable sections as indicated.

C. Provide flush steel bar drop handles for lifting removable sections, one at each end of each section.

2.16 ABRASIVE METAL NOSINGS

A. Fabricate from galvanized ASTM A36 Grade 36 steel with welded studs as necessary with abrasive surface treatment. Sample nosings shall be submitted for approval by the Engineer.

2.17 CAST-IRON WHEEL GUARDS

A. Provide wheel guards of 3/4-inch-thick, hollow-core, gray-iron castings; of size and shape indicated. Provide holes for countersunk anchor bolts and grouting.

2.18 EXPANDED METAL SHEET PANELING

A. Provide expanded metal sheets at missile barriers, canopy infill, and at station access points.

1. Carbon steel standard ¾ #9 S 10 ga, hot-dipped galvanized finish
2. Format:

   a. bond sheared SWD, random sheared LWD
   b. for missile barrier panels: diamonds oriented vertically
   c. for paneling at station entrances: diamonds oriented horizontally
   d. for canopy infill: diamonds oriented horizontally

3. Attachment to support frame:

   a. Flat washers with bolts and nuts
   b. Fasteners shall be spaced as indicated on drawings, at equal distances on each sheet, but in no case less than 18-inches and in the same relative positions on all sheets

2.19 FINISHES, GENERAL

A. Comply with the National Association of Architectural metal Manufacturer's (NAAMM) "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

2.20 STEEL AND IRON FINISHES

A. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:

1. Exteriors (SSPC Zone 1B) and Items Indicated to Receive Zinc-Rich Urethane Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning ".
2. Interiors (SSPC Zone 1A): SSPC-SP 7, "Brush Off Blast Cleaning".
3. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be field welded, embedded in concrete or masonry, unless otherwise indicated. Extend priming of partially embedded members to a depth of 2 inches.
4. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel", for shop painting.
5. Comply with SSPC-PA 2, "Measurement of Dry Coating Thickness with magnetic Gages".

B. Hot-Dip Galvanizing: For steel exposed to the elements, weather or corrosive environments and other steel indicated to be galvanized, provide coating for iron and steel fabrications applied by the hot-dip process. Comply with ASTM A 123 for fabricated products and ASTM A 153 for hardware. Provide thickness of galvanizing specified in referenced standards. The galvanizing bath shall contain high grade zinc and other earthly materials. Fill vent holes and grind smooth after galvanizing.

C. Hot-Dip Galvanizing And Factory-Applied Primer for Steel: Provide hot-dip galvanizing and factory-applied prime coat, certified OTC/VOC compliant less than 2.8 lbs/gal. and conforming to EPA and

Commonwealth of Massachusetts requirements. Apply primer within 12 hours after galvanizing at the galvanizer's plant in a controlled environment meeting applicable environmental regulations and as recommended by the primer coating manufacturer. Blast cleaning of the surface is unacceptable for surface preparation. Primer shall have a minimum two year re-coat window for application of finish coat. Coatings must meet or exceed the following performance criteria:

1. Abrasion: ASTM D 4060, CS17 Wheel, 1,000 gram load.
2. Adhesion: ASTM D 3359, Method B, 5 mm crosshatch.
3. Humidity Resistance: ASTM D 4585.
4. Salt Spray (Fog): ASTM B 117.

D. Hot-Dip Galvanizing and Factory-Applied Urethane Primer and Finish for Steel: Provide factory-applied architectural coating over primed hot-dip galvanized steel matching approved samples.

1. Primer coat shall be factory-applied polyamide epoxy primer. Apply primer within 12 hours after galvanizing at the galvanizer's plant in a controlled environment meeting applicable environmental regulations and as recommended by the primer coating manufacturer.
2. Finish coat shall be factory-applied color-pigmented architectural finish. Apply finish coating at the galvanizer's plant, in a controlled environment meeting applicable environmental regulations and as recommended by the finish coating manufacturer.
3. Coatings shall be certified OTC/VOC compliant and conform to applicable regulations and EPA standards.
4. Apply the galvanizing, primer and coating within the same facility and provide single-source responsibility for galvanizing, priming and finish coating.
5. Blast cleaning of the galvanized surface is not acceptable.
6. Primer shall meet or exceed the following performance criteria:
   a. Abrasion: ASTM D 4060, CS17 Wheel, 1,000 gram load.
   b. Adhesion: ASTM D 3359, Method B, 5 mm crosshatch.
   c. Humidity Resistance: ASTM D 4585.
   d. Salt Spray (Fog): ASTM B 117.

7. Finish coat shall meet or exceed the following performance criteria:
   a. Abrasion: ASTM D 4060, CS17 Wheel, 1,000 gram load.
   b. Adhesion: ASTM D 3359, Method B, 5 mm crosshatch.
   c. Graffiti Resistance: After drying for seven days, no staining from acrylic, epoxy, epoxy-ester and alkyd spray paints, ballpoint pen, crayons, magic marker, black shoe polish, and lipstick.
   d. Weathering: ASTM D 1014, 45 degrees facing south.
   e. Surface Burning Characteristics: ASTM E 84
   f. QUV: ASTM G53, ES-40 bulbs, 4 hours light, 4 hours dark.
   g. Salt Spray (Fog): ASTM B 117.

8. Clearcoat over finish coat shall meet or exceed the following performance criteria:
   a. Abrasion: ASTM D 4060, CS17 Wheel, 1,000 gram load.
   b. Adhesion: ASTM D 3359, Method B, 5 mm crosshatch.
   c. Graffiti Resistance: After drying for seven days, no staining from acrylic, epoxy, epoxy-ester and alkyd spray paints, ballpoint pen, crayons, magic marker, black shoe polish, and lipstick.
   d. Weathering: ASTM D 1014, 45 degrees facing south; and ASTM D 4141C EMMAQUA-NTW.
   e. QUV: ASTM G53, ES-40 bulbs, 4 hours light, 4 hours dark.
   f. Salt Spray (Fog): ASTM B 117.

g. Flexibility: ASTM D 522, Method B, cylindrical mandrel.
h. Hardness: ASTM D 3363 (Pencil).

E. Zinc-Rich Primer: Urethane zinc rich primer compatible with topcoat Specified in Section 09900. Provide primer with a VOC content of 340 g/L (2.8 lb/gal.) or less per OTC ozone standards when calculated according to 40 CFR 59, Subpart D (EPA Method 24). Provide Tnemec Series 394 Perimerprime or Ameron Series 68HS at 3.0 mils DFT or approved equal by DuPont or Carboline.

2.21 STAINLESS-STEEL FINISHES

A. Remove tool and die marks and stretch lines or blend into finish.

B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean. Remove all heat tint at welds and heat affected zones.

2.22 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. As-Fabricated Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).

C. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

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 no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturer's written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for operable partitions securely to and rigidly brace from building structure.

C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in this Section.

D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in this Section. Grout baseplates of columns supporting steel girders after girders are installed and leveled

3.3 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations, unless otherwise indicated.
2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Galvanized steel pipe railing will be measured by the linear foot complete in place.

B. No separate measurement will be made for galvanized steel safety walkway grating, but all costs in connection therewith shall be included in the Contract Lump Sum Price for Item 0552.115 – Grating. All preparation and incidental work necessary to accomplish the installation, including all fabrication, bolts, anchors, washers, galvanizing, etc., will be considered incidental to the Lump Sum price.

C. Separate measurement will not be made for miscellaneous metal items in conjunction with the South Acton station platform and canopies, complete in place, but all costs in connection therefore shall be included in the Contract Lump Sum and Unit Prices for Item No. 0613.018 – Access Platform; Item No. 0613.020 – Platform Canopies.

D. Separate measurement will not be made for miscellaneous metal items in conjunction with the South Acton Station pedestrian overpass and ramps complete in place, but all costs in connection therefore shall be included in the Contract Lump Sum 0211.615 – Pedestrian Overpass.

E. Separate measurement will not be made for miscellaneous metal items in conjunction with the south Acton Station pedestrian overpass and ramps complete in place, but all costs in connection therefore shall be included in the Contract Lump Sum 0211.615 – Pedestrian Overpass.

F. Separate measurement and payment will not be made for all other miscellaneous metal items associated with signs, benches, and other elements of the project, but all costs in connection therefore, including bolts, anchors, washers, galvanizing, factory painting, and other incidentals necessary to complete the items, shall be included in the contract lump sum and unit price for the item or items or work to which they pertain.

4.2 PAYMENT

A. Payment for galvanized steel pipe railing will be made at the Contract Unit price as specified above. Payment shall constitute full compensation for preparation and submission of shop drawings, fabrication, galvanizing, transportation, installation, labor, materials, anchor bolts, equipment, and incidentals necessary to complete installation in accordance with the above described work and to the satisfaction of the Engineer.

B. Payment for galvanized steel safety walkway grating will be made at the Contract Lump Sum price bid for Item 0552.115. Payment shall constitute full compensation for preparation and submission of design calculations and shop drawings, fabrication, galvanizing, transportation, installation, labor, materials, anchor bolts, equipment, and incidentals necessary to complete installation in accordance with the above described work and to the satisfaction of the Engineer.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0211.615	PEDESTRIAN OVERPASS	LS
0547.050	GALVANIZED STEEL PIPE RAILING	LF
0552.115	GRATING	LS
0615.019	ACCESS PLATFORM	LS
0615.020	PLATFORM CANOPY	SF
1365.000	PREFABRICATED STRUCTURES	LS

END OF SECTION

SECTION 06100

ROUGH CARPENTRY

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies rough carpentry items as indicated on the contract drawings and as specified herein, including, but not limited to, the following:

1. Treated Timber Edge Strip at the High Level Platform

2. Miscellaneous lumber: concealed wood nailers, furring, shimming, blocking, grounds, and panels required for proper installation of other work.
3. Wood planks for benches.
4. Tackboard surface for poster case.

B. Coordinate all work of this section with the work of other trades. Take all necessary field measurements prior to starting fabrication or beginning shop drawings.

C. Furnish to the Contractor all items included as work of this section that are to be built into work of other trades. Furnish all necessary templates and information required by those trades to properly locate such items.

1.2 RELATED WORK

A. Carefully examine all of the Contract Documents for requirements which affect the work of this section.

B. Other specification sections which directly relate to the work of this section include, but are not limited to, the following:

1. Section 05500 – Miscellaneous Metals.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of the Contract and Division 1 Specification Sections.

B. Product Data: Submit manufacturers' product data, installation instructions, use limitations and recommendations for each material used. Provide certifications stating that materials comply with requirements.

C. Treatment Data: Wood treatment data from chemical treatment manufacturer.

1. Preservative Treatment: Include certification by treatment plant stating type of solution and pressure process used, net amount of preservative retained, and compliance with applicable standards.

1.4 DELIVERY, STORAGE AND HANDLING

A. General: Handle and store materials in strict compliance with manufacturers' instructions and recommendations. Handle and store materials at Project site to prevent water damage, staining, or other physical damage.

B. Delivery: Sequence deliveries to avoid delays but minimize on-site storage.

C. Storage: Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber as well as plywood and other panels. Provide for air circulation within and around stacks and under temporary coverings including polyethylene and similar materials.

PART 2 - PRODUCTS

2.1 TIMBER EDGE STRIP AND MISCELLANEOUS LUMBER

A. General: Provide lumber for the timber edge strip at the high level platform and for the support or attachment of other construction including nailers, blocking, furring, stripping, and similar members. Include all fasteners and other hardware.

B. Lumber Standards: Furnish lumber manufactured to comply with PS 20 "American Softwood Lumber Standard" and with applicable grading rules of inspection agencies certified by American Lumber Standards Committee's (ALSC) Board of Review.

C. Grade Stamps: Provide lumber with each piece factory marked with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.

D. Nominal sizes are indicated, except as shown by detail dimensions. Provide actual sizes as required by PS 20, for moisture content specified for each use.

1. Provide dressed lumber, S4S, unless otherwise indicated.
2. Provide seasoned lumber with 19 percent maximum moisture content at time of dressing and shipment for sizes 2 inches or less in nominal thickness, unless otherwise indicated.
3. Fabricate miscellaneous lumber from dimension lumber of sizes indicated and into shapes shown.

E. Lumber shall be free of splits, twists and warps.

F. Fasteners:

1. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
2. Non-Corrosive Fasteners: Provide fasteners with a hot dip zinc coating per ASTM A 153 or of AISI Type 304 stainless steel, unless otherwise indicated.
3. Nails, Wire, Brads and Staples: FS FF N 105.
4. Power Driven Fasteners: National Evaluation Report NER 272.
5. Wood Screws: ANSI B18.6.1.
6. Lag Bolts: ANSI B18.2.1.
7. Bolts: ASTM A 307, Grade A; with ASTM A 563 hex nuts and flat washers.

G. Preservative Wood Treatment By Pressure Process:

1. General: Obtain preservative-treated lumber complying with AWPA Standard C2. Mark each treated item with AWPB or SPIB Quality Mark Requirements. Coat surfaces cut after treatment to comply with AWPA M4.
2. Above-Ground Wood Treatment: Pressure treat with waterborne preservatives to a minimum retention of 0.25 pcf.
3. Treat wood nailers, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing; and items in contact with masonry or concrete.
4. Complete fabrication of treated items prior to treatment, where possible. If cut after treatment, coat cut surfaces to comply with AWPA M4. Inspect each piece of lumber after drying and discard damaged or defective pieces.

2.2 WOOD PLANKS

A. Wood species and Cuts: Provide as follows:

1. Provide fresh-cut untreated IPE with the following properties:

Grade:	Select; all heart; no sap
Appearance:	Smooth with no splinters
Decay resistance:	25 years
Fire rating class:	NFPA - A
Bending strength (Fb):	25,400 psi
Shear Strength:	2,060 psi
Hardness:	3,680 lbs
Unit weight for design purposes:	69 pcf.

B. All hardwood material shall be free from "white rot" and other deformities. Members shall be cut without bark, wane or sapwood. Intermediate light-colored heartwood shall be permitted. Well-boxed and sound heart shall be permitted in members 10 inches by 10 inches and larger.

C. Members shall be straight-grained (maximum slope to grain of 1:10) and without knots or excessive bending or twisting.

D. Members shall be full-cut to actual (not nominal) dimensions with a tolerance of ±3/16" unless otherwise indicated.

E. Cutting and Drilling: Pre-drill and counter sink when using screws or bolts.

F. End Sealing: Seal all ends after cutting with latex based end sealer to reduce end checking.

G. Fastening: Provide fasteners with hot-dipped zinc coating per ASTM A-153 or of ASI type 304 stainless steel, unless otherwise indicated.

H. Finish: Apply a penetrating, pigmented, UV inhibiting sealer

2.3 TACKBOARD SURFACE

A. Description: Burlap bonded with waterproof adhesive to structural fiberboard.

1. Thickness: ½ inch.
2. Treated for resistance to moisture, protection against termites, rot and fungus.
3. Mod. Of Rupture: 650-900 psi.
4. Mod. Of Elasticity: 69,000 psi.

5. Density: 24-26 lb/cf.
6. Hardness (Janka Ball): 200 lb.
7. Tensile Strength: 350-600.
8. Water Absorption by volume:
   a. 2 hours immersion: 5%.
   b. 24 hours immersion: 15%.
9. Expansion from 50% to 90% relative humidity (max.): 0.25%.
10. Thermal Conductivity (k factor): 0.42.
11. R value: 1.11.
12. NRC: 0.20.
13. ASTM E 84 Fire Rating: Class III (or C).

B. Products:

1. Burlap Panels by Homasote Company;
2. Bulletin Boards by AARCO Products Inc
3. Tackboards by ADP LEMCO INC
4. Or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION:

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of work. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Scribe and trim work to provide accurate fit. Install members plumb and true to line and level.

B. Coat cut edges of preservative treated wood to comply with AWPA M4.

C. Securely fasten carpentry as indicated and according to applicable codes and recognized standards.

1. Use fasteners of appropriate type and length.
2. Predrill members when necessary to avoid splitting wood.
3. Use fine finishing nails for exposed nailing, countersunk and filled flush with woodwork.

D. Install units with minimum number of joints possible, using full length pieces.

3.3 WOOD GROUNDS, NAILERS, BLOCKING, AND SLEEPERS

A. Install wood grounds, nailers, blocking, and sleepers where shown, or where required for attachment of other work even if not shown. Form to shapes as shown and cut as required for true line and level of work to be attached. Coordinate location with other work involved.

B. Attach to substrates as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise indicated.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

A. Separate measurement and payment will not be made for the work of this Section complete in place, but all costs therefore shall be included in the Contract Unit and Lump Sum price for the items of work to which they pertain. The timber edge strip will be included as part of Pay Item No. 0613.019 ACCESS PLATFORM.

END OF SECTION

SECTION 07115

BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies cold-applied, emulsified-asphalt dampproofing applied to the exterior of below-grade surfaces on concrete and masonry foundation and retaining walls.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
1. Section 07141 - COLD FLUID-APPLIED WATERPROOFING
2. Section 07190 – WATER REPELLENTS

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include recommendations for method of application, primer, number of coats, coverage or thickness, and protection course.

B. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.

C. Qualification Data: For Installer and for Testing and Inspection Agency.

D. Product Test Reports: From a qualified independent testing agency indicating and interpreting test results of waterproofing for compliance with requirements, based on comprehensive testing of current waterproofing formulations.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain primary dampproofing materials and primers through one source from a single manufacturer. Provide secondary materials recommended by manufacturer of primary materials.

1.4 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit asphalt dampproofing to be performed according to manufacturers' written instructions.

B. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has thoroughly cured.

PART 2 - PRODUCTS

2.1 BITUMINOUS DAMPPROOFING

A. Cold-Applied, Emulsified-Asphalt Dampproofing, Brush and Spray Coats: ASTM D 1227, Type III, Class 1.

2.2 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Euclid Chemical Company.
2. Henry Company.
3. Karnak Corporation.
4. Meadows, W. R., Inc.
5. Sonneborn, Div. of ChemRex, Inc.

2.3 MISCELLANEOUS MATERIALS

A. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended by manufacturer.

B. Asphalt-Coated Glass Fabric: ASTM D 1668, Type I.

C. Protection Course, Polystyrene Type: Fan-folded, rigid, extruded-polystyrene board insulation; nominal thickness not less than 3/16 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Applicator present, for compliance with manufacturer's requirements for surface smoothness and other conditions affecting performance of work. Begin dampproofing application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protection of Other Work: Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.

B. Clean substrates of projections and substances detrimental to work; fill voids, seal joints, and apply bond breakers if any, as recommended by prime material manufacturer. Concrete shall be allowed to cure for a minimum of 5 days after form removal prior to dampproofing application.

C. Patch holes with mortar and allow to properly cure prior to dampproofing application.

3.3 APPLICATION

A. Comply with manufacturer's written recommendations unless more stringent requirements are indicated or required by Project conditions to ensure satisfactory performance of dampproofing.

1. Apply additional coats if recommended by manufacturer or required to achieve coverages indicated.
2. Allow each coat of dampproofing to cure 24 hours before applying subsequent coats.
3. Apply from finished-grade line to top of footing, extend over top of footing, and down a minimum of 6 inches over outside face of footing.
4. Extend 12 inches onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
5. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where shown as "reinforced", by embedding an 8-inch-wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat required for embedding fabric is in addition to other coats required.

B. On Concrete Foundations: Apply two brush or spray coats at not less than 1.5 gal./100 sq. ft. for first coat and 1 gal./100 sq. ft. for second coat.

C. On Unparged Masonry Foundation Walls: Apply primer and two brush or spray coats at not less than 1.5 gal./100 sq. ft. for first coat and 1 gal./100 sq. ft. for second coat.

D. On Backs of Concrete and Masonry Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft.

3.4 INSTALLATION OF PROTECTION COURSE

A. Install protection course over completed-and-cured dampproofing. Comply with dampproofing material manufacturer's written recommendations for attaching protection course. Support protection course with spot application of trowel-grade mastic where not otherwise indicated.

3.5 CLEANING

A. Remove dampproofing materials from surfaces not intended to receive dampproofing.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Separate measurement and payment will not be made for bituminous dampproofing of abutments, retaining walls complete in place, but all costs, therefore, shall be included in the item of work to which it pertains.

END OF SECTION

SECTION 07190

WATER REPELLENTS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies water-repellent coatings for the following surfaces:

1. Concrete vertical surfaces.
2. Concrete horizontal surfaces.
3. Cast stone.
4. Brick masonry.
5. Concrete unit masonry (unpainted and unglazed).
6. Portland cement plaster.
7. Stonework.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 07920 - JOINT SEALANTS; Joint sealers.
2. Section 03300 – Cast–In–Place Concrete

1.2 PERFORMANCE REQUIREMENTS

A. Performance Testing: Provide water repellents that comply with test-performance requirements indicated, as evidenced by reports of tests performed by manufacturer by a qualified independent testing agency on manufacturer's standard products applied to substrates simulating those on Project using same application methods to be used for Project.

B. Absorption: Minimum 90 percent reduction of absorption after 24 hours in comparison of treated and untreated specimens.

1. Brick: ASTM C 67.
2. Stone: ASTM C 97.
3. Concrete Unit Masonry: ASTM C 140.
4. Hardened Concrete: ASTM C 642.

C. Permeability: Minimum 80 percent water-vapor transmission in comparison of treated and untreated specimens, per ASTM D 1653.

D. Water Penetration and Leakage through Masonry: Minimum 90 percent reduction in leakage rate in comparison of treated and untreated specimens, per ASTM E 514.

E. Durability: Maximum 5 percent loss of water repellency after 2500 hours of weathering in comparison to specimens before weathering, per ASTM G 154.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

1. Include manufacturer's printed statement of VOC content.
2. Include manufacturer's standard colors.

B. Samples: For each type and color of water repellent and substrate indicated, 12 by 12 inches in size, with specified water-repellent treatment applied to half of each Sample.

C. Manufacturer Certificates: Signed by manufacturers certifying that water repellents comply with requirements.

D. Qualifications: Installer.

E. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Test Application: Apply a finish sample for each type of water repellent and substrate required. Duplicate finish of approved sample.

1. Locate each test application as directed by Engineer.
2. Size: 10 square feet.
3. Final approval by Engineer of color and water-repellent application will be from test applications.

1.5 PROJECT CONDITIONS

A. Limitations: Proceed with application only when the following existing and forecasted weather and substrate conditions permit water repellents to be applied according to manufacturers' written instructions and warranty requirements:

1. Ambient temperature is above 40 deg F.
2. Concrete surfaces and mortar have cured for more than 28 days.
3. Concrete or brick masonry walls are not treated prior to 30 days after building close-in.
4. Rain or snow is not predicted within 24 hours.
5. Application proceeds more than 24 hours after surfaces have been wet.
6. Substrate is not frozen, or surface temperature is above 40 deg F.
7. Windy conditions do not exist that may cause water repellent to be blown onto vegetation or surfaces not intended to be treated.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace materials that fail to maintain water repellency specified in Part 1 "Performance Requirements" Article within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PENETRATING WATER REPELLENTS

A. Silane/Siloxane-Blend, Penetrating Water Repellent: Clear, silane and siloxane blends with 3.3 lb/gal. or less of VOCs.

1. Available Products:
   a. Anti-Hydro International, Inc.; Aridox 40 VOC.
   b. Hydrozo, a division of ChemRex; Enviroseal 7 or Hydrozo 100.
   c. Pecora Corporation; 910W.
   d. ProSoCo, Inc.; SL 100 Water Repeller.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrate of substances that might interfere with penetration or performance of water repellents. Test for moisture content, according to water-repellent manufacturer's written instructions, to ensure that surface is dry enough.

1. Cast-in-Place Concrete Section 03300: Remove oil, curing compounds, laitance, and other substances that could prevent adhesion or penetration of water repellents.
2. Clay Brick Masonry: Clean clay brick masonry per ASTM D 5703.

B. Test for pH level, according to water-repellent manufacturer's written instructions, to ensure chemical bond to silicate minerals.

C. Protect adjoining work, including sealant bond surfaces, from spillage or blow-over of water repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of water repellent being deposited on surfaces. Cover live plants and grass.

D. Coordination with Sealants: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and cured.

1. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those used in the work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect the substrate before application of water repellent and to instruct Applicator on the product and application method to be used.

B. Apply a heavy-saturation spray coating of water repellent on surfaces indicated for treatment using low-pressure spray equipment to achieve application rate recommended by manufacturer. Prepare a test area to determine proper application rate as recommended by manufacturer. Comply with manufacturer's written instructions for using airless spraying procedure, unless otherwise indicated. Thoroughly mix prior to application.

1. Precast Concrete: At Contractor's option, first application of water repellent on precast concrete units may be completed before installing units. Mask sealant-bond surfaces to prevent water repellent from migrating onto joint surfaces.

3.3 CLEANING

A. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application as work progresses. Repair damage caused by water-repellent application. Comply with manufacturer's written cleaning instructions.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Water repellents will be measured as per square foot complete in place, including all preparation, accessories and incidentals.

4.2 PAYMENT

A. Payment for water repellents will be made at the Contract unit price for the quantities as specified above.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0710.701	WATER REPELLENT COATINGS	SF

END OF SECTION

SECTION 07411

PREFORMED METAL CANOPY SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies fabricating, furnishing and installing a leak-tight preformed (corrugated) metal canopy system and gutter system as indicated on the contract drawings and as specified herein, including, but not limited to, the following:

1. Mechanically attached preformed metal canopy panel system, including trim and closure pieces, with panels and connections fabricated for the design loads specified and spans and details shown in the Drawings.
2. Shop-fabricated steel gutter.
3. All necessary fasteners and connections (except for structural steel indicated on the Drawings), sealers, sealants, flashings and counter-flashings as required to make the systems leak tight.

1.2 RELATED WORK

A. Carefully examine all of the Contract Documents for requirements which affect the work of this section.

B. Other specification sections which directly relate to the work of this section include, but are not limited to, the following:

1. Section 05041 – Hot Dip Galvanizing, for finishing of the preformed metal canopy panel system.
2. Section 07920 – Sealants and Caulking, for requirements for furnishing and installing exposed sealants.

1.3 STANDARDS

A. The following standards form a part of these Specifications.

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

1. ASTM E 283 Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
2. ASTM E 331 Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.

C. American Iron and Steel Institute (AISI):

1. Specification for the Design of Cold-Formed Steel Structural Members.

D. American Institute of Steel Construction (AISC):

1. Code of Standard Practice.

E. American Society of Civil Engineers (ASCE):

1. ASCE-7, Minimum Design Loads for Buildings and Other Structures.

F. Federal Specifications (FS).

G. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

1. Architectural Sheet Metal Manual.

1.4 SYSTEM PERFORMANCE

A. Design Wind Pressure: Canopy system shall safely withstand Design Wind Pressure of 35 psf, and all loads prescribed by codes and authorities having jurisdiction. Loads shall be resisted in both positive and negative directions.

B. Design Live and Dead Load, including unbalanced roof snow load and drift loads: Canopy system shall safely withstand structural loading calculated in accordance with applicable building code, and as follows:

1. Canopy system shall support a 250 lb. concentrated load distributed over a 4 inch square bearing plate at the center of a panel at the maximum span used on the project without buckling the rib, permanent deflection or other perceptible damage.

C. Canopy system shall be designed for a maximum deflection under positive loading of L/180.

D. Air infiltration of the canopy system shall be limited to 0.06 CFM/ft2 at a positive pressure differential of 1.57 psf when tested in accordance with ASTM E 283.

E. There shall be no water penetration through the canopy system when the canopy system is tested per ASTM E 331 at a positive pressure differential of 6.24 psf or 20% of the design wind pressure whichever is greater. The test pressure need not exceed 12 psf.

F. Thermal Movement: Canopy system shall permit thermal movement resulting from an ambient temperature range of 120°F without leaking water.

1.5 QUALITY ASSURANCE

A. Subdivision of Work: Assign the complete canopy system to one manufacturer and one installer, including, but not limited to, panels, fasteners, caps, trims, and counter-trims.

B. Source: Provide canopy systems that are the products of one manufacturer. Provide secondary materials that are acceptable to the manufacturer of the canopy system.

1. Manufacturers Qualifications: The manufacturer shall have had a minimum of ten (10) years experience in the successful completion of projects employing similar materials, applications, and performance requirements.

C. Engineering: Provide the services of a Professional Engineer, registered in the Commonwealth of Massachusetts, to design, seal and certify that the work of this section meets or exceeds the performance requirements specified in this section.

D. Installer: The installer shall have a minimum of ten (10) years experience in the successful completion of projects of the type required by this Section, and shall be acceptable to the manufacturer of the canopy system. The manufacturer shall certify that the installer is acceptable to the manufacturer.

E. Pre-installation Conference: A pre-installation conference shall be held to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work.

F. Field Leakage Test: Authority may employ an independent testing agency to make in-place field tests for water leakage and other performance criteria. Test will generally include a prolonged water spray test similar to AAMA 501.3, except water shall be applied for two minutes per lineal foot of joint being tested. Any uncontrolled leakage will be considered a failure.

1. Modify installation techniques as necessary to eliminate leaks. Make watertight all leaking areas.
2. At no additional cost to the Authority, provide all retesting and remedial work necessary because of failures found by testing.

1.6 WARRANTY

A. Canopy System Warranty: Provide manufacturer's standard written warranty signed by manufacturer, installer and Contractor, agreeing to repair or replace work which exhibits defects in materials or workmanship. "Defects" is defined to include, but is not limited to, leakage of water, abnormal aging or deterioration, and failure to meet performance requirements.

1. Warranty Period: Twenty-five (25) years from date of Final Acceptance.

1.7 SUBMITTALS

A. General: Submit the following in accordance with Conditions of the Contract and Division 1 Specification Sections.

B. Manufacturer's Qualifications: Submit a list of five (5) similar completed projects with addresses of the project location, architect, and owner.

C. Installer's Qualifications and Experience:

1. Submit a list of five (5) similar completed projects with metal roofing and canopy systems, with addresses of the project location, architect, and owner.
2. Certification that the installer is acceptable to the manufacturer.

D. Submit product data, test reports, and certifications in accordance with quality assurance and system performance requirements specified herein.

E. Submit panel shop drawings consisting of design and erection drawings, finish specifications, and other data necessary to clearly describe the design, materials, sizes, layouts, construction details, and erection. Submit small-scale layouts of panels and gutters and large-scale details of edge conditions, joints, fastener and sealant placement, flashings, penetrations, and special details. Distinction must be made between factory and field assembled work.

1. A Professional Engineer, registered in the Commonwealth of Massachusetts, shall sign and seal the shop drawings.
2. Do not begin fabrication without approved shop drawings.

F. Submit structural design calculations, in accordance with the AISI Specification for the Design of Cold-Formed Steel Structural Members, for the canopy system. Show how the design load and other performance requirements have been satisfied.

1. A Professional Engineer, registered in the Commonwealth of Massachusetts, shall seal and certify the calculations.

G. Samples: Submit samples for initial selection, showing complete range of colors, textures and finishes available for each material exposed in the finish work. Base on the colors, textures and finishes selected by the Engineer, submit representative samples of each material exposed in the finish work, including the following, showing the range of color and finish variations expected:

1. Panel: Full panel width by 12 inches long.
2. Gutter: Full cross section by 12 inches long.
3. Fasteners: Two (2) of each type with statement of intended use.
4. Closure: One (1) metal closure and one (1) foam closure as required.
5. Sealants: One (1) sample of each type with statement of intended use.
6. Expanded metal sheet infill: One (1) 12-inch x 12-inch panel with perimeter welded plates.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver to the site, preformed metal canopy system materials and products in unopened factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect against all possible damage. Sequence deliveries to avoid delays, but minimize on-site storage. All unacceptable materials shall be replaced at no additional cost to the Authority.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Provide canopy system products of one of the following manufacturers that meet or exceed the specified requirements, or provide an Engineer-approved equal:

1. Centria.
2. Metecno-Morin.
3. Berridge.

2.2 CANOPY SYSTEM PRODUCT

A. Preformed (corrugated) metal canopy panels:

1. Dimensions:
   a. 36 inches of coverage width.
   b. 3 inch deep unsymmetrical ribs spaced at 12 inches.
   c. Approximately 2 inch top (narrow) rib width and 5 inch bottom (wide) rib width.
2. Material: Zinc coated (galvanized) steel conforming to ASTM A 653 SQ Grade 37 with G90 coating. Material shall be minimum 18 gauge with smooth surface texture.

B. Flashing and Trim: Fabricated in the same material, gauge, finish and color as the metal panels.

C. Finish: Per Section 05041 – Hot Dip Galvanizing.

D. Accessories:

1. Canopy system fasteners shall be #14 minimum diameter, self-tapping, with hex head.
   a. Exposed fasteners shall be 300 series stainless steel with 5/8" bonded neoprene and stainless steel washers coated to match the exterior panel color.
   b. Concealed fasteners shall be 300 series stainless steel.
2. Closures shall be metal and/or foam as required. Foam shall be a pre-cut profile closure of closed cell foam. Metal closures shall be fabricated from the same material, gauge, finish, and color as the exterior metal panel.
3. Sealants:
   a. Hidden sealant at all side laps, end laps, and flashing details shall be gun grade non-curing butyl or polymeric non-skinning butyl tape to ensure weather tightness.
   b. Exposed sealant – provide Joint Sealant JS-2 as specified in Section 07920 – Sealants and Caulking.

2.3 CANOPY SYSTEM FABRICATION

A. Canopy system components shall be fabricated in the factory for field assembly to the greatest extent possible. Avoid field cutting.

2.4 GUTTERS

A. Materials:

1. Ferrous Metals:
   a. Metal Surfaces – General: Use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names, and roughness.
   b. Steel Sheet: ASTM A1011 and A1008.
2. Fasteners:
   a. General:
      1) Unless otherwise indicated in drawings, all fasteners shall be Type 316 stainless steel.
      2) Select fasteners for type, grade, and class required.
   b. Self-tapping Machine Screws: FS FF-S-92.
   c. Plain Washers: Round with bonded neoprene pad, FS FF-W-92.
3. Sealant: Gun grade non-curing butyl or polymeric non-skinning butyl tape.

B. Finish: Per Section 05041 – Hot Dip Galvanizing.

C. Fabrication:

1. Shop-fabricate gutters to greatest extent possible. Comply with details shown and with applicable requirements of SMACNA "Architectural Sheet Metal Manual" and other recognized industry practices.
2. Fabricate for water-tightness and weather-resistant performance, durability, strength, and uniform appearance, sufficient to permanently prevent leakage, damage, or deterioration of the work.
3. Form work to fit profiles and slopes indicated. Pre-slot holes for field-installed fasteners.
4. Form sheet metal work with sharp creases, without excessive oil-canning, buckling, and tool marks, true to line and levels indicated.

5. Weld flanges continuously, complying with AWS recommendations. Grind exposed welds smooth and flush to match and blend with adjoining surfaces. Remove weld brazing and solder splatter, flux, slag and oxides from finished surfaces.
6. Sealant Joints: Where movable joints are indicated, form metal to provide for proper installation of sealant in compliance with SMACNA standards.

PART 3 - EXECUTION

3.1 INSPECTING SUBSTRATE

A. Verify conditions as satisfactory to receive work.

B. Do not begin installation until all unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions.

3.2 CANOPY SYSTEM INSTALLATION

A. Strictly comply with the manufacturer's instructions and recommendations, except where more restrictive requirements are specified in this Section.

1. Remove all protective materials and labels from the canopy components as they are installed.
2. Install work to be truly straight and square.
3. Provide work as indicated on approved shop drawings.
4. Install work with uniform, tight, interlocking joints.
5. Provide trims, sealers, fillers and gaskets as necessary to make assembly weathertight and watertight.
6. Comply with the requirements of Section 07920 – Sealants and Caulking, including testing and compatibility.
7. Comply with SMACNA Architectural Sheet Metal Manual for installation of flashings and sheet metal work.
8. Metal filings caused by cutting and drilling shall be immediately removed from finished surfaces to prevent rusting and staining.

B. Coordinate work with other trades as required to insure proper flashing and seals with adjoining construction.

3.3 GUTTER INSTALLATION

A. Anchor units of work securely in place by methods indicated, providing for thermal expansion of metal units; conceal fasteners where possible, and set units true to line and slopes indicated. Install work with laps, joints, and seams that will be permanently watertight and weatherproof.

B. Joint Sealers: Install sealants where indicated and where required for water-tight performance of the system.

3.4 TOUCH-UP AND REPAIR

A. Touchup with air dry coating material per Section 05041 - Hot Dip Galvanizing.

B. Repair minor damage to eliminate all evidence of repair. Remove and replace work which cannot be satisfactorily repaired.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. No separate measurement will be made for preformed metal canopy systems, but all costs in connection therewith shall be included in the Contract Unit and Lump Sum prices for Item No. 0211.615 – Pedestrian Overpass and for Item No. 0613.020 – Platform Canopy. All preparation and incidental work necessary to accomplish the installation, including all flashing, trim, fasteners, closures, sealants, etc., will be considered incidental to the Contract Unit Price.

4.2 PAYMENT

A. Payment for preformed metal canopy panel system items will be made at the contract unit and lump sum prices as specified above.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0211.615	PEDESTRIAN OVERPASS	LS
0613.020	PLATFORM CANOPY	SF

END OF SECTION

SECTION 07578

METHYL METHACRYLATE ACRYLIC POLYMER CONCRETE OVERLAY SYSTEM

PART 1- GENERAL

1.1 GENERAL:

A. This Section specifies Methyl Methacrylate Acrylic (MMA) Polymer Concrete Bridge Deck Overlay Systems applied over pre-cast concrete platform units.

1.2 RELATED SECTIONS

A. Section 03300 – CAST-IN-PLACE CONCRETE

B. Section 03410 – PLANT-PRECAST STRUCTURAL CONCRETE

C. Section 07920 – JOINT SEALANTS

D. Section 09360 – MODULAR TACTILE SURFACES

1.3 SUBMITTALS

A. Samples for Color Selection

1. Initial Color Selection: Submit color plates showing the full range of standard colors and blends available from the proposed broadcast aggregate manufacturer.

2. Initial Color Selection Samples: Based upon a review of the color plates for the proposed broadcast aggregate provided, the Engineer shall provide ratios for up to 3 custom mix colors or color blends for the fabrication of the Color Selection Samples. Color Selection samples shall be fabricated using the complete overlay system and the aggregate color(s)/blend(s) selected by the Engineer for sample production. A total of four 12"x12" samples shall be submitted for each color selected for sample production. Each sample shall be accurately labeled to indicate the aggregate color, blend ratio, gradation and coverage rates for the overlay system components.

3. Final Color Selection Sample Production: A second round of color selection samples may be required based upon a review of the samples in the context of the individual station sites. A single set of four 12"x12" samples shall be submitted for final color selection. Final color selection samples shall be accurately labeled to indicate the aggregate color, blend ratio, gradation and coverage rates for the overlay system components.

B. Verification Samples: After completion of the color selection process, Submit four 12"x12" samples and four 6"x6" samples fabricated using the exact installation procedures proposed for use on this contract, including mix ratios, coverage rates, aggregate color, gradation and application method.

C. Submit two 1-pound samples from each manufacturing lot of the aggregate in the final color/blend and grade selected.

D. Manufacturer's Submittals:

1. Material Brochures and technical data sheets for all overlay system components including but not limited to primers, resins, and aggregates.
2. Descriptive data and specific recommendations for surface preparation, testing, initiating, mixing, application, and curing specific to all phases of this application. Include detailed mixing and application instructions which define the specific tools, equipment and procedures proposed for use on the project. Submittal data shall be complete and comprehensive from the start of surface preparation through the completion of the second coat of top-coat installed after installation of the pre-cast concrete platform units at their final location. Upon acceptance of the proposed installation instructions, provide four (4) copies of the mixing instructions on laminated heavy card stock for use by the Authorities field personnel.
3. Presentation package for use at the installation seminar. Manufacturer shall also provide a written summary of the installation seminar including but not limited to documentation of any questions asked, follow-up information requested, and variations in the presentation from the approved presentation package and the attendance list.
4. Proposed testing procedures, forms and criteria for evaluation. Testing submittal shall include a summary of the required testing prepared by the Manufacturer, any additional testing that may be recommended by the Manufacturer and a detailed description of the proposed materials and equipment to be used by the testing agency.
5. Description of commonly occurring installation defects, including proposed repair procedures where appropriate.
6. Specific instructions for storage and handling of material. Submittal shall include confirmation from the Contractor and the manufacturer that these instructions have been reviewed and appropriate equipment and other provisions will be provided.
7. Lot numbers and corresponding dates of manufacture for all overlay system materials.
8. Manufacturer's Material Safety Data Sheets (MSDS) for all overlay system component products proposed for use. The contractor shall be responsible for making copies of the MSDS readily available at the site during overlay application.
9. Cleaning and maintenance manual for the overlay system: Provide three (3) copies, bound in three-ring binders, of cleaning and maintenance instructions for use by the Authority. Cleaning instructions should include recommended procedures for cleaning a variety of surface contaminants including paint, oils, etc, which can be expected to be encountered. Maintenance instructions should include at a minimum; requirements for periodic cleaning, general repairs and pertinent material data and installation instructions for the overlay system components installed including but not limited to concrete repair materials, primer, body coat resin, top coat, and sealants.
10. Manufacturer's proposed daily report form. Report form shall include the following at a minimum:
    a. Plan of Station Platform which shall include a unique identification code for each pre-cast concrete platform units. Panel limits shall be consistent with that shown on the layout drawing for the pre-cast concrete platform units.
    b. Name and signature of the Manufacturer's Representative who completed the form and the date for which the report was prepared. Space shall also be provided listing the name of the Contractor's on-site representative(s) present during the day's work.
    c. Summary description of work completed during that day.

d. Summary description of the weather including temperature range and relative humidity.
e. Documentation of any required testing performed, including locations, types and results.
f. Documentation of any deviations from the approved procedures and installation methods including any changes in tools or equipment.
g. Pertinent data indexed by pre-cast concrete platform unit relative to the overlay materials placed including:
    1) Written verification that surface preparation was adequate in the judgment of the manufacturer's representative and the method used to make this judgment including references to the results of all required testing.
    2) Substrate, overlay system component(s), dew point and ambient temperatures at the time of primer, body coat slurry and top coat applications.
    3) Mix proportions, material usage and approximate coverage rate for the primer, body coat slurry and top coats as applied to each successive unit.
    4) Lot numbers from packages of material used.
h. Representative photos of the work in progress on the day of the report.
i. Spaces for written names and signatures of the Contractor and Authority representatives who were present during the work.
j. Any other pertinent information recommended by the manufacturer for inclusion in the daily record.
k. Daily reports shall be due a maximum of two-days after the date of the report, however all daily reports shall be submitted to and accepted by the Engineer prior to delivering specific pre-cast concrete platform units to the site or requesting any inspections.

E. Contractor's Submittals

1. Details of Contractor's methods of protecting adjacent surfaces during overlay installation.
2. Details of proposed storage methods, including descriptive data documenting compliance with manufacturer's requirements for storage and handling of the material.
3. Details of proposed methods for removing overlay system components from adjacent surfaces.
4. Copy of Sample Warranty: provide a copy of the proposed sample warranty.
5. The Contractor shall provide, at the pre-award conference, the relevant information regarding the selected overlay system components including but not limited to the names of the manufacturers of the overlay system, aggregate, and sealants and the proposed applicator if not self performed.
6. Provide a copy of ICRI Guideline for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays - including a complete set of Concrete Surface Profile Chips

F. Certifications

1. Submit certification indicating that all proposed materials including but not limited to overlay system components, aggregates, concrete repair materials, and sealants are compatible. Certification shall specifically mention all products proposed for use on this project.

2. Provide a commitment, in writing from the overlay system manufacturer, that representative(s) of their technical services department shall be present at each site at all times during application of the overlay system. This commitment shall also include acknowledgement by the manufacturer that their representative(s) are responsible for performing quality control with respect to the application of the overlay system as well as including the name(s) and qualifications of the manufacture's technical representatives proposed for use on this Contract. Members of the manufacturer's sales department are not acceptable to serve as the required on-site technical representative. The responsibility of the manufacturer's representative for quality control shall be limited to the overlay system and shall not be construed as replacing the Contractor's overall responsibility for quality control. **Failure of the manufacturer to provide this commitment will disqualify their material from eligibility for use on this project.**
3. Submit a commitment from the Contractor, and applicable sub-contractors, acknowledging that the manufacturer's representative is responsible for quality control with respect to the application of the overlay system and that said representative shall have full authority to stop work at any time that overlay installation is not being performed in accordance with the requirements of this specification. This commitment shall also acknowledge that the presence of the manufacturer's representative does not relieve the contractor from their overall responsibility for quality control.
4. Format and source of required certifications:
   a. Certifications and Commitments from manufacturers shall be provided in the form of a letter, on the manufacturer's letterhead, from the director of technical service, or similar person qualified to represent the manufacturer. Certifications shall not be provided by members of the manufacturers sales or marketing staff unless specific documentation is provided stating that said person is authorized to issue said certification or commitment.
   b. Certifications and Commitments from the Contractor shall be in the form of a letter, on the Contractor's, or applicable sub-contractor, letterhead from the Contractor's, or sub-contractor's designated Project Manager. Certifications and Commitments provided by a sub-contractor shall be accompanied by a corresponding certification or commitment from the Prime Contractor.
   c. Certification pertaining to Quality Control relating to the work of this section shall be due within 10 days of receipt of Notice to Proceed for the Contract.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. The manufacturer of the overlay system shall provide adequate documentation demonstrating experience in the production of overlay systems of the types proposed for use in this specification. Documentation of said experience shall be provided in the form of a listing of representative projects installed in similar climates and over similar substrate conditions, over the last ten years. Representative project listing shall include a minimum of two projects within the New England Region. Provide owner contact information for each representative project.
2. The applicator of the overlay system shall provide adequate documentation of successful installation of overlay systems of the types proposed for use in this specification. Documentation of said experience shall be provided in the form of a listing of representative projects demonstrating successful installation of MMA overlay systems in similar climates and environments. Listing shall include at a minimum three projects utilizing the same generic type of overlay system. The proposed applicator shall also be subject to the approval of the overlay system manufacturer. Provide owner contact information for each representative project.

B. Commencement of overlay installation shall constitute prima facie evidence that the Contractor and the manufacturer have inspected the substrate conditions and that they have been adequately prepared and that they represent a suitable substrate for the application of the overlay system. Contractor and manufacturer shall be responsible for visiting the site and making a determination as to the extent of the preparatory work that will be required to adequately prepare the pre-cast platform units surface to receive the proposed overlay system.

C. The Manufacturer shall conduct a one-day technical presentation/installation seminar for attendance by the Contractor, the Engineer, and representatives of the Authority departments. This presentation shall include the following:

1. Description of required surface preparation techniques, including representative images of adequately prepared surfaces.
2. Review of proposed installation procedures and recommended tools and techniques.
3. Review of commonly occurring defects and methods for repair.
4. Hands-on fabrication of two sample panels, minimum size of each panel shall be 10'-0" x10'-0". The manufacturer shall provide adequate material; Contractor shall provide equipment, tools and labor to prepare each sample panel. Procedures used to construct the sample panels shall reflect the procedures, equipment, and tools proposed for used on this project.

   The date, time, location and sample presentation documents for the proposed training seminar shall be provided within 5 days of the Notice of Award. The seminar shall be at a location within the Boston Metropolitan area which is acceptable to the Authority. Date of the seminar shall be a minimum of twenty one (21) days after receipt of the training seminar submittal by the Engineer.

D. The finished surface of the overlay system shall be uniform in color, texture, and appearance. All edges that terminate at walls, discontinuities and other embedded items shall be sharp, uniform, and cosmetically acceptable with no thick or ragged edge. The Contractor shall work out an acceptable masking technique to ensure the acceptable finish

of all edges. Prepare a mock-up panel minimum size shall be 5'x10' or larger based upon platform geometry. A second mock-up shall be prepared where the overlay will be installed on a sloped surface. Mock-ups shall include application of sealant materials. Acceptance of the mock-up by the Engineer shall be required before the contractor may proceed with the installation of the overlay system on the balance of the pre-cast concrete platform units.

E. The following tests shall be performed by the Contractor under the oversight of the Manufacturer's representative and in the presence of the Engineer. Results of all tests shall be recorded on the daily report form, see paragraph 1.04 – Submittals, for the day the testing is performed. Preliminary test results shall be provided to the Engineer within 24 hours of the completion of testing on any given day.

1. Temperature: Measure air, substrate, overlay system component(s) and dew point temperatures immediately prior to mixing and applying any component of the overlay system. Dew point shall be calculated from air temperature and humidity using standard tables, copies of which shall be provided by the manufacturer and shall be available for ready reference at the mixing location at each site. The manufacturer's representative shall be responsible for ensuring the temperature testing equipment, which shall be provided by the Contractor, is in good working order, has been properly calibrated and that temperature tests have been performed in manner consistent with the equipment manufacturer's instructions. Record temperature hourly or more frequently when weather, substrate or other conditions require adjustment of the mix proportions.
2. Moisture: Perform tests for moisture in the substrates to receive the overlay system in accordance with the requirements of ASTM D4263 and F1869. Tests shall be completed immediately prior to the application of the Overlay system. A vapor emissions value of 4 pounds per 1,000 sf/24 hours or less shall constitute an acceptable test, unless more stringent values are recommended by the manufacturer. After a failed test, individual test specimens shall be allowed to cure a minimum of seven (7) additional days before repeating the F 1869 moisture test. Frequency and types of test shall be as per the manufacturer's recommendations, except that the following minimum frequencies shall be utilized:
   a. A minimum of one (1) D 4263 test shall be completed on each unit; the presence of moisture under the plastic sheet shall constitute a failed test.
   b. Perform one (1) set of F 1869 tests on the units produced during on each unique day of production and at the frequencies identified in the test standard.
   c. Perform additional F 1869 tests on all units for which moisture is observed to be present under the plastic sheet.
3. Adhesion Testing: Perform tests to quantitatively and qualitatively evaluate the adequacy of surface preparation as described below:
   a. Quantitative Tests: Perform 'pull-off' strength tests using portable adhesion testers at frequencies as follows:
      1) Substrate preparation: Test shall be performed to determine the nominal tensile strength of the existing concrete surfaces. This testing shall be performed immediately upon completing surface preparation activities and prior to the initiation of any required repairs and shall be performed in strict accordance with the test procedures included in ASTM C1583.
         a. Frequency of testing shall be a minimum of 1 per every pre-cast concrete platform unit.
         b. A tensile adhesion value of 250 psi shall constitute a successful test. This value shall be the average of

three samples per test location. All three samples used in the determination of this average value must be above 150 psi. Values resulting from samples exhibiting failure of the adhesive connecting the sample to the testing apparatus shall not be included in the computation of the adhesion value.

c. Dollies shall be 2 inch nominal.

2) Overlay Adhesion: This testing shall be performed as part of the pre-final and final inspection process. Tests for determining the 'pull-off' strength of the overlay system shall be performed using test procedures included in ASTM C1583.

a. Frequency of testing shall be a minimum of 1 per every pre-cast concrete platform unit.

b. A tensile adhesion value of 250 psi, or more based upon the measured tensile strength of the existing concrete surface, shall constitute a successful test. This value shall be the average of three samples per test location. Values resulting from samples exhibiting bond failure at the concrete overlay interface (defined as a failure within 1/16" of the top of the substrate material), failure of the overlay or of the adhesive connecting the sample to the testing apparatus shall not be included in the computation of the adhesion value.

c. Dollies shall be 2 inch nominal.

3) Testing devices shall provide a direct reading of the force applied (in pounds) during the testing and shall have a minimum capacity of 5,000 pounds. Testing devices that give direct readouts in psi are not acceptable for use.

b. Qualitative Tests: Prior to commencing overlay application each workday, perform 'pattie' tests at a frequency of every 300 square feet of overlay surface to be installed, or a minimum of one per platform unit. Acceptable 'pattie' test results shall be recorded on the daily report form prior to commencing overlay installation.

c. Locations of all required tests shall be selected by the Engineer.

Provide samples of overlay system components as requested by the MBTA Lab.

F. Reference Standards

1. ACI 302.1 – Guide for Concrete Floor and Slab Construction
2. ACI 308 – Standard Practice for Curing Concrete
3. ACI 503R – Use of Epoxy Compounds with Concrete
4. ASTM C307 – Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacing
5. ASTM C579 – Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
6. ASTM C580 – Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
7. ASTM C1583 – Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off) Method.

8. ASTM D543 – Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents
9. ASTM D570 – Standard Test Method for Water Absorption of Plastics
10. ASTM D638 – Standard Test Method for Tensile Properties of Plastics
11. ASTM D695 - Standard Test Method for Compressive Properties of Rigid Plastics
12. ASTM D696 – Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C With a Vitreous Silica Dilatometer
13. ASTM D790 – Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
14. ASTM D2240 – Standard Test Method for Rubber Property—Durometer Hardness
15. ASTM D4060 - Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
16. ASTM D4258 - Standard Practice for Surface Cleaning Concrete for Coating
17. ASTM D4259 - Standard Practice for Abrading Concrete
18. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials
19. ASTM F1869 - Moisture Test by Use of Calcium Chloride

G. Pre-Construction Conference:

Prior to commencement of work, a job-site meeting of Contractor, Applicator, Engineer and the overlay manufacturer's representative shall be held to verify all conditions, procedures and to examine and discuss any issues affecting the work of this Section.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original sealed containers, clearly marker with manufacturer's name, product information and batch number.

B. Store materials in a dry, protected area at a temperature between 35°F and 80°F, or as per the manufacturer's written instructions. Materials that have been stored in temperatures outside of this temperature range for an extended time (as defined by manufacturer) shall be replaced with new materials at the direction of the Engineer.

C. Follow all manufacturer's specific instructions and prudent safety practices for storage and handling.

1.6 JOB CONDITION

A. The material and air and surface temperatures shall be in the range of 35°F and 90°F during application and cure.

B. The relative humidity in the specific location of the application shall be less than 85 percent and the surface temperature shall be at least 5°F above the dew point.

C. Protect all adjacent surfaces not to be coated with masking and covers.

1.7 WARRANTY

A. The Contractor, applicator(s) and overlay system manufacturer shall provide the Authority with a ten-year joint guarantee on the platform overlay system. A single warranty shall be provided which shall include the following:

1. The Contractor and applicator(s) shall be responsible for providing all labor, equipment and incidentals required to perform warranty repairs resulting from failure of the overlay system due to workmanship. The Manufacturer of the overlay system shall be responsible for providing materials required to perform warranty repairs, except in the event that the warranty repairs are required as a result of a manufacturing defect in the overlay system materials, in which case all costs including labor and equipment shall be covered by the manufacturer.
2. Provisions for periodic inspections of the overlay system condition. Inspections shall be performed in the presence of representatives of all parties to the warranty and any defects in the overlay system identified during the course of these inspections shall be promptly repaired. In the event of a disagreement as to the cause of a specific defect a final determination shall be made by and independent testing firm employed by the Authority. Periodic inspections shall occur in the first and last year of the warranty term and a minimum of every two years in between.
3. Repairs required to correct defects resulting from failure of or differential movement of the station structure or damage caused by impact or vandalism shall be excluded from the warranty.
4. The commencement date for the warranty shall correspond to the date of final completion.
5. Guarantee beyond the initial general contract Warranty shall be in the form of an insurance policy with the MBTA as sole beneficiary and which shall be sufficient to cover the costs of removing and replacing any or all of the overlay system installed under this contract in the event of a failure of some portion of the overlay system during this guarantee period

PART 2—PRODUCTS

2.1 MATERIALS

A. Methyl Methacrylate Acrylic (MMA) Polymer Concrete Overlay System:

1. Bridgemaster High Performance Polymer Slurry Overlay as manufactured by Stirling Lloyd Products, Inc.
2. Denedeck Bridge Overlay System as manufactured by Deneef Construction Chemicals, Inc.
3. T-18 MMA Polymer Concrete Overlay System as manufactured by Transpo Industries
4. or other approved equal

B. Equivalent materials of other manufacturers may be substituted on approval of the Engineer. Requests for substitution will be considered, if submitted with the Contractor's Bid. Request shall include all required submittal data included in Articles 1.4 and 1.5 above including the respective manufacturer's technical literature for each product giving the name, generic type, descriptive information, recommended application rates, representative projects and certified test reports showing results to equal the performance criteria as specified herein and the Manufacturer's Safety Data Sheet (MSDS) for each product. No request for substitution shall be considered that would change the generic type of coating system specified. Manufacturers of Approved Systems shall be of single source.

2.2 PRODUCT REQUIREMENTS

A. Primer: Low viscosity methyl-methacrylate reactive resin for priming and sealing of concrete substrates. Primer shall meet or exceed the following performance properties.

1. Percentage Reactive Resin: 100%
2. Water Absorption, ASTM D570: <.5%/24 hours
3. Tensile Strength, ASTM D638: 4,000 psi
4. Tensile Modulus, ASTM D638: 400,000 psi
5. Water Vapor Transmission, ASTM E96: <3.0 gal/sf/24 hours
6. Elongation at Break, ASTM D638: 10%
7. Flash Point: greater than 43 °F

B. Body Coat Resin Component: Low viscosity methyl-methacrylate reactive resin for mixing with proprietary fillers to form the slurry layer of the overlay system. Body coat resin shall meet or exceed the following performance properties:

1. Percentage Reactive Resin: 100%
2. Water Absorption, ASTM D570: <0.1%/ 24 hours
3. Tensile Strength (Neat), ASTM D638: 500 psi
4. Elongation at Break, ASTM D638: 50%
5. Hardness, ASTM D2240: 40D
6. Flash Point: greater than 45 °F

C. Body Coat Slurry: A mixture of bodycoat resin and a prepackaged filler component that when properly mixed shall meet or exceed the following performance properties:

1. Compressive Strength, ASTM D695: 1,500 psi
2. Flexural Strength, ASTM D790: 1,000 psi
3. Tensile Strength, ASTM C307: 750 psi
4. Tensile Adhesion, ASTM D4541: 250 psi
5. Water Absorption, ASTM D570: .5%/24 hours
6. Elongation at Break, ASTM D638: 10%
7. Coefficient of Thermal Expansion, ASTM D696: 4.4x10-5/°F

D. Broadcast Aggregate:

1. Materials shall be of clean dry, angular material and shall be free from dirt, clay or other contaminants.
2. Gradation: Aggregate gradation shall be as recommended by the overlay system manufacturer when the overlay system is used as a wearing surface for heavy pedestrian use and exposure to metal bladed snow removal equipment.

Topcoat: Colorless, low viscosity methyl-methacrylate reactive resin for use as a top coat. Top Coat resin shall meet or exceed the following performance properties:

1. Percent Reactive Resin: 100%
2. Water Absorption, ASTM D570: 0.1%/24 hours
3. Tensile Strength, ASTM D638: 2,000 psi
4. Tensile Modulus, ASTM D638: 300,000 psi
5. Water Vapor Transmission, ASTM E96: <3.0 gal/sf/24 hours
6. Chemical Resistance, ASTM D543
   a. effect of weak acids: none
   b. effect of strong acids: slight

c. effect of alkalis: none
d. effect of salt solutions: none
e. effect of gasoline, oil, grease: none
f. effect of sunlight, UV: none

7. Taber Abrasion Resistance, ASTM D4060: 54 mg loss/1000 cycles CS17 wheel.

2.3 MATERIAL PREPARATION

A. Initiate and mix all material in strict accordance with the procedures which have been developed for use on this project for the respective material being used.

B. Initiate and mix only enough product to satisfy immediate application requirements based on the Manufacturer's published Pot Life.

PART 3 – EXECUTION

3.1 INSPECTION OF SURFACES

A. The surface on which the overlay system is to be applied shall be left without projections, holes or honeycombs. Cracks and joints shall be treated in accordance with the overlay systems manufacturer's recommendations.

B. The manufacture's representative shall inspect all surfaces to receive the overlay system and report in writing to the Contractor and the Engineer any surfaces that are not suitable for the application of the material.

C. The Contractor shall not proceed with application until the all required testing has been performed, the mock-up has been reviewed and accepted by the Engineer and the adequacy of the surface preparation and moisture level of the concrete has been accepted in writing, by the manufacturer's representative. In the event any surfaces are determined to be unacceptable, surface preparation procedures shall be repeated or revised until acceptable conditions are achieved.

3.2 INTENT AND WORKMANSHIP

A. It is not the intent to herein describe all of the details for the coating system. Items and details not otherwise specified, but required to complete the system shall be provided as part of the work at no additional cost to the Authority.

B. Manufacturer's technical representative shall be on site at all times during MMA application and testing and shall review and accept in writing all surfaces and preparation procedures, observe application procedures and oversee all recommended testing. The manufacturer shall supply such service as required, at no additional cost to the Authority.

C. Initiate and mix all material in strict accordance with the job specific instructions and procedures for the respective materials being used.

D. Excess broadcast aggregate shall be vacuumed from the platform surface; aggregates shall not be removed using forced air blowers. Aggregates shall not be blown or otherwise disposed within the track ballast.

3.3 SURFACE PREPARATION

A. Do not apply curing agents, sealers, hardeners or other products to concrete slabs that will affect the penetration or adhesion of the coating.

B. Surfaces that are heavily contaminated with petroleum or other process products shall be cleaned in accordance with the appropriate de-greaser, detergent or other effective cleaner/surfactant followed by thorough rinsing with fresh water to remove the accumulation prior application.

C. Surface shall be clean and visibly dry, especially in cracks and other deep surface discontinuities, prior to application.

D. Mechanical Surface Preparation and Cleaning:

1. All concrete surfaces to receive the overlay system shall be mechanically prepared using mechanical vacuum enclosed shot blasting in accordance with ASTM D4259. All surface and embedded accumulations of paint, toppings, hardened concrete layers, laitance, power trowel finishes and other similar surface characteristics shall be removed leaving concrete surface having an ICRI surface profile (CSP-5) and exposing the upper facades of concrete aggregate.
2. Scarification of concrete surface shall be completed in strict adherence to the depth requirements specified herein.
3. Platform surfaces that are inaccessible to the shot blasting equipment shall be mechanically abraded to the same specified degree of cleanliness, soundness and profile using needle guns, or other suitably effective equipment. The use of drum scarifiers, bush-hammers, bush heads and other similar equipment shall not be acceptable.
4. Cracks in the platform surface 3/16" and smaller shall be repaired using a suitable MMA crack sealing system in accordance with the manufacturer's recommendations.
5. Allow the surface to dry or force dry with heat and circulating air to ensure all surfaces, especially discontinuities, are visibly dry. Provide several passes with high-pressure air blast to remove dirt. Clean all surfaces to receive overlay at the beginning of every shift.

E. Tactile warning tiles shall be protected, and or removed during the surface preparation, cleaning and overlay installation. Concrete surface below tactile warning tiles shall not receive a mechanically shot blasted or other wise scarified surface treatment.

3.4 BOND TESTS

A. Perform surface preparation bond tests specified above at the frequencies recommended by the manufacturer or the minimum rates noted above, prior to commencing overlay application. In the event bond tests do not produce satisfactory results, Contractor shall perform additional surface preparation and re-perform tests until satisfactory results are achieved.

B. 'Pattie' Tests

1. Place small area of primer on the surface upon which the pattie test is to be performed and allow to cure for one hour. Prepare a test 'pattie' by mixing specified primer/sealer with sufficient clean, silica sand and form 4" nominal diameter patty. Patty shall be allowed to cure for one hour break cured patty off deck surface with mallet and chisel. Failure should occur across concrete aggregate. An acceptable

pattie test shall exhibit 100% concrete with fractured aggregate across the entire bottom surface of the pattie. Patties exhibiting less that complete coverage of concrete and fractured aggregate shall constitute a failed test.

2. If bond tests do not break with acceptable results, as determined by the Engineer, repeat surface preparation efforts until successful bond tests have been achieved. Consult with manufacturer if problems persist. Do not apply floor coating system over concrete surfaces where bond tests have failed.

C. Perform overlay adhesion bond tests specified above at the frequencies recommended by the manufacturer but no less than the minimum rates noted above, prior to commencing overlay application. In the event overlay adhesion tests do not produce satisfactory results, Contractor shall remove and replace overlay materials at no additional cost to the Authority. Contractor may perform additional tests as required to identify limits of inadequate bond at no additional cost to the Authority.

D. Submit documentation on forms developed by the manufacturer accompanied by the successful test samples, 'pucks' and 'patties', including a plan noting the approximate location of each test to the Engineer.

DECK COATING APPLICATION

A. System shall consist of applying the Primer/Sealer, allowing time for cure, and then applying the Boadycoat, Broadcast Aggregate and Topcoat in the sequence and application rates or thicknesses as specified herein.

B. Do not proceed with the application of primer until the results of Moisture and Tensile testing have been provided to the Engineer for their review. Do not apply primer to portions of the platform surface that cannot be completed during the current shift or work period. Primed surfaces shall not be left exposed overnight except in areas as specifically directed to provide only a primed surface.

C. Apply only primer to portion of platform concrete under the tactile warning tiles, and along the front face of platform to receive timber rubbing strip.

D. Open only the containers of components to be used in each specific application. Refer to the manufacturer's data sheets for pot-life/temperature relationship to determine size of batches to mix.

E. Measure, add, and mix the initiator into the resin in the proportions included in the manufacturer's project specific installation instructions.

F. Size the batches, open, mix, and apply Topcoat ensuring formation of a continuous, uniform film at the rate of coverage specified.

G. Surface preparation and application of overlay shall be completed in a controlled environment prior to installation of platform panels at site.

3.6 OVERLAY SCHEDULE

Application rates shall be as per the Manufacturer's recommendations, but shall meet the following minimum requirements:

Primer:	2 coats at a wet film thickness of 15 mil each. The thickness shall be measured by the manufacturer's representative in the presence of the Engineer and accepted by the Engineer, by using a mil gauge at intervals of not more than 1,000 square feet of primer applied per shift. Broadcast 20-30 mesh sand at a rate of 4 lbs/100sf into both coats of primer.
Body coat Slurry:	Apply minimum 3/16" thickness equal to a wet film thickness of approximately 188 mil. Thickness of overlay shall be such that when complete, final surface with aggregate is flush with lowest surface (non-domed surface) of the tactile warning tiles. The thickness shall be measured by the manufacturer's representative in the presence of the Engineer and accepted by the Engineer, by using a mil gauge at intervals of not more than 1,000 square feet of primer applied per shift.
Broadcast Aggregate:	Apply aggregate immediately into the wet bodycoat until complete coverage is achieved and no portion of the Slurry layer is visible. Monitor the surface and apply additional aggregates where portions of the slurry may be come visible. Initial aggregate application shall occur before the bodycoat achieves initial set, typically 1-3 minutes after application.
1st Topcoat:	1 coat of Colorless Topcoat applied in the shop (prior to installation of the pre-cast concrete platform unit at the site) at no more than 100 sq. ft. per gallon. Broadcast 20-30 mesh sand into the first coat of top coat at a rate recommended by the manufacturer.
Patching:	Following installation of precast concrete platform panels at the site, all recesses in platform walking surface shall be patched with a MMA polymer Concrete, and the MMA overlay shall be patched using the application procedure developed for use on this project
2nd Topcoat	1 coat of colorless Topcoat applied after installation at the site and completion of any required patching or repairs and adhesion testing, specifically at lifting locations or areas damaged during transport or installation.

3.7 INSPECTION

A. Request acceptance, by the manufacturer's representative, of the primer/sealer coat before application of the Bodycoat commences; likewise for the Bodycoat before application of the Topcoat.

B. All work that is not acceptable to the Manufacturer's Representative, Engineer or Authority must be corrected before consideration of final acceptance.

C. Upon completion of the overlay installation in the shop naturally age coated precast concrete platform units in direct sunlight for a minimum of 7 days prior to transport to the site for installation.

3.8 REPAIRS

A. Delaminations or areas exhibiting unacceptable adhesion values: In the event areas of delaminations or unacceptable adhesion values are present the overlay shall be removed back to sound well bonded material as determined by the Engineer and reinstalled. Panels where delaminations cover over 20% of the area of the panel shall be rejected and the overlay system shall be removed and reapplied at no additional cost to the Authority.

B. Surface defects: Grind all wrinkles, ridges or other similar surface defects to achieve a smooth surface even with the surface of the surrounding overlay. Once the surface defect has been removed apply a second body coat application with aggregate. Thickness of the second bodycoat application shall be 1/16-1/8". For panels where surface defects cover 20% or more of the finish surface of the pre-cast concrete platform unit the entire unit shall receive a second bodycoat application.

C. Repair overlay adhesion test locations in accordance with approved repair procedure.

CLEAN-UP

A. Remove any material spatters and other material that is not where it should be. Remove masking and covers, taking care not to contaminate surrounding area.

B. Repair any damage to finish or surrounding surfaces that arise from either the application or clean-up effort.

PART 4—MEASUREMENT AND PAYMENT

4.1 MEASUREMENT AND PAYMENT

Separate measurement and payment will not be made for the work required under this section but all costs in connection therewith shall be included in the contract lump sum for Item 0613.019 – Access Platform.

END OF SECTION

SECTION 07600

FLASHING AND SHEET METAL

PART 1 – GENERAL

1.1 SCOPE OF WORK

A. Provide all labor, equipment, and materials fabricate and install the following.

1. Edge strip and flashing.
2. Fascia and trim.
3. Counterflashings over bituminous base flashing.
4. Counterflashings for roof accessories.
5. Base flashing coverings.
6. Fascia and edge metal.
7. Lead flashing for bituminous membranes.
8. Other components.
9. Counterflashings at roof mounted equipment and vent stacks

1.2 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General Supplementary Conditions and Division 1 Specification Sections, Apply to this Section.

B. RELATED SECTIONS

None

1.3 REFERENCES

ASTM A-446	Specification for steel sheet
ASTM B-209	Specification for aluminum sheet
ASTM B-221	Specification for aluminum extruded shape
FS QQ-L-201	Specification for Lead Sheet
ASTM A792	Steel Sheet, Aluminum-Zinc Alloy-Coated, by the Hot-Dip Process
ASTM B32	Solder Metal
ASTM B209	Aluminum and Alloy Sheet and Plate
ASTM B486	Paste Solder
ASTM D226	Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D486	Asphalt Roof Cement, Asbestos-free
FS O-F-506	Flux, Soldering, Paste and Liquid
FM	Loss Prevention Data Sheet
NRCA	National Roofing Contractors Association - Roofing Manual
SMACNA	Architectural Sheet Metal Manual

1.4 SUBMITTALS

A. Submit under provisions of Section 01300 - Submittals.

B. Product Data: Provide manufacturer's specification data sheets for each product in accordance with Section 01300.

C. Provide approval letters from metal manufacturer for use of their metal within this particular roofing system type.

D. Submit two samples, 12 x 12 inch in size illustrating typical external corner, internal corner, valley, junction to vertical dissimilar surface, material and finish.

E. Shop Drawings

1. For manufactured and shop fabricated gravel stops, fascia, scuppers, and all other sheet metal fabrications.
2. Shop drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashing, terminations, and installation details.
3. Indicate type, gauge and finish of metal.

F. Certification

1. Submit roof manufacturer's certification that metal fasteners furnished are acceptable to roof manufacturer.
2. Submit roof manufacturer's certification that metal furnished is acceptable to roofing manufacturer as a component of roofing system and is eligible for roof manufacturer's system warranty.
3. Submit certification that metal and fastening system furnished is Tested and Approved by Factory Mutual for 1-90 Wind Up-Lift Requirements.

G. Manufacturer's Product Data

1. Metal material characteristics and installation recommendations.
2. Submit color chart prior to material ordering and/or fabrication so that equivalent colors to those specified can be approved.

1.5 QUALITY CONTROL

A. Reference Standards

1. Comply with details and recommendations of SMACNA Manual for workmanship, methods of joining, anchorage, provisions for expansion, etc.
2. Factory Mutual Loss Prevention Data Sheet 1-49 windstorm resistance 1-90.

B. Contractor's Warranty

1. The Contractor shall provide the Owner with a notarized written warranty assuring that all sheet metal work including caulking and fasteners to be watertight and secure for a period of two years

from the date of final acceptance of the building. Warranty shall include all materials and workmanship required to repair any leaks that develop, and make good any damage to other work or equipment caused by such leaks or the repairs thereof.

1.6 QUALIFICATIONS

A. Fabricator and Installer: Company specializing in sheet metal flashing work with 5 years experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened containers or packages with labels intact and legible.

B. Stack pre-formed and pre-finished material to prevent twisting, bending, or abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.

C. Prevent contact with materials which may cause discoloration or staining.

PART 2 - PRODUCTS

2.1 APPROVED EQUIVALENT

A. Contractor must submit any product not specified a minimum ten days before the bid date to Architect in order for product to be considered for approval. The Architect will notify Contractor, in writing, of decision to accept or reject request.

2.2 MATERIALS

A. Miscellaneous Metals and Flashings:

1. All installed metal to be fabricated in the same material, gauge, finish and color as preformed (corrugated) metal canopy panels: zinc coated (galvanized) steel conforming to ASTM A 653 SQ Grade 37 with G90 coating. Material shall be minimum 18 gauge with smooth surface texture.

2.3 RELATED MATERIALS

A. Metal Primer: Zinc chromate type.

B. Plastic Cement: ASTM D 4586.

C. Sealant: Specified in Section 07900 or on drawings.

D. Lead: Meets Federal Specification QQ-L-201, Grade B, four pounds per square foot.

E. Solder: ANSI/ASTM B32; 95/05 type.

F. Flux: FS O-F-506.

G. Underlayment: ASTM D2178, No15 asphalt saturated roofing felt.

H. Slip Sheet: Rosin sized building paper.

I. Fasteners:

1. Corrosion resistant screw fastener as recommended by metal manufacturer. Finish exposed fasteners same as flashing metal.
2. Fastening shall conform to Factory Mutual 1-90 requirements or as stated on section details, whichever is more stringent.

J. Termination Bars:

1. Shall be aluminum unless otherwise recommended by membrane manufacturers.
2. Material shall be .125" x 1" (minimum) aluminum conforming to ASTM B-221, mill finish. Bar shall have caulk cup as required.

PART 3 - EXECUTION

3.1 PROTECTION

A. Protect contact areas of dissimilar metals with heavy asphalt or other approved coating, specifically made to stop electrolytic action.

3.2 GENERAL

A. Install work watertight, without waves, warps, buckles, fastening stress, or distortion, allowing for expansion and contraction.

B. Fastening of metal to walls and wood blocking shall comply with SMACNA Architectural Sheet Metal Manual, Factory Mutual I-90 wind uplift specifications and/or manufacturer's recommendations whichever is of the highest standard.

C. All accessories or other items essential to the completeness of sheet metal installation, whether specifically indicated or not, shall be provided and of the same material as item to which applied.

D. Metal fascia and copings shall be secured to wood nailers at the bottom edge with a continuous cleat. Cleats shall be at least one gauge heavier than the metal it secures.

3.3 INSPECTION

A. Verify roof openings, curbs, pipes, sleeves, ducts, or vents through roof are solidly set, cant strips and reglets are in place, and nailing strips located.

B. Verify membrane termination and base flashings are in place, sealed, and secure.

C. Beginning of installation means acceptance of existing conditions.

D. Field measure site conditions prior to fabricating work.

3.4 SHOP FABRICATED SHEET METAL

A. Installing Contractor shall be responsible for determining if the sheet metal systems are in general conformance with roof manufacturer's recommendations.

B. Metal work shall be shop fabricated to configurations and forms in accordance with recognized sheet metal practices.

C. Hem exposed edges.

D. Angle bottom edges of exposed vertical surfaces to form drip.

E. All corners for sheet metal shall be lapped with adjoining pieces fastened and set in sealant.

F. Joints for gravel stop fascia system, cap flashing, and surface-mount counterflashing shall be formed with a 1/4" opening between sections. The opening shall be covered by a cover plate or backed by an internal drainage plate formed to the profile of fascia piece. The cover plate shall be embedded in mastic, fastened through the opening between the sections and loose locked to the drip edges.

G. Install sheet metal to comply with Architectural Sheet Metal manual, Sheet Metal and Air Conditioning Contractor's National Associations, Inc.

3.5 FLASHING MEMBRANE INSTALLATION

A. METAL EDGE DETAIL

1. See details for scuppers. For manufactured edge metal, scuppers shall be factory fabricated.
2. Accessories: Joint covers, corners, supports, strip flashing at joining, fastenings and other accessories shall be included.
3. Install continuous cleat fasten 6" O.C. Fasten flange to wood nailer every 6" staggered.
4. Install new metal edge hooked to continuous cleat.
5. Prime metal edge at a rate of 100 square feet per gallon and allow to dry.

B. COPING CAP/ SURFACE MOUNTED COUNTERFLASHING

1. Copings shall be provided with factory fabricated welded watertight coping accessories such as miters, transitions, end caps, etc. and finished to match coping system.
2. Accessories: Joint covers, corners, supports, strip flashing at joinings, fastening, and other accessories shall be included.
3. Install continuous cleat fasten 6" O.C.
4. Install new coping cap hooked to continuous cleat.

C. HATCH

1. Counterflashing shall be provided with watertight accessories such as miters, transitions, end caps, etc. and finished to match.
2. Accessories: Joint covers, corners, fasteners, strip flashing at joinings, fastening, and other accessories shall be included.
3. Install pre-manufactured expansion joint cover. Fasten sides 8" O.C. with fasteners and neoprene washers.
4. Set equipment on neoprene pad and fasten as required by equipment manufacturer.

D. ROOF DRAIN

1. Prime lead/copper at a rate of 100 square feet per gallon and allow to dry.
2. Set lead/copper flashing (30" square minimum) in a 1/4" bed of mastic.
3. Install clamping ring and strainer assure all plies are under the clamping ring.

E. PLUMBING STACK

1. Prime flange and sleeve at a rate of 100 square feet per gallon and allow to dry.
2. Install properly sized sleeves in a 1/4" bed of elastomeric sealant.
3. Turn sleeve a minimum of 1" down inside of stack.
4. Caulk intersection of the membrane and flange with elastomeric sealant.

PART 4 – MEASUREMENT AND PAYMENT

4.1 GENERAL

No separate measurement or payment will be made for work required under this Section. All costs in connection therewith shall be considered incidental to the item or items of work to which they pertain.

4.2 PAYMENT ITEMS

Item No.	Description	Unit
0613.020	PLATFORM CANOPY	SF
0211.615	PEDESTRIAN OVERPASS	LS

END OF SECTION

SECTION 07911

COMPRESSION SEALS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Work Included: This Section specifies preformed compression seals.

B. Work of this section shall also include expansion joint at Columbia Road Piers including all preparation, labor, materials, equipment, submittals, accessories and incidentals to the complete the work to satisfaction of the engineer.

C. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 05500 - MISCELLANEOUS METALS.
2. Section 07920 - JOINT SEALANTS.

1.02 DESIGN CRITERIA

A. The Contract Drawings indicate joint dimensions, anticipated amount of movement, location, traffic conditions, and other factors affecting choice of compression seal type and configuration.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's literature describing products, including the following:

1. Requirements for joint and surface preparation, temperature and humidity, and other items required for successful completion of the work.
2. Details and methods of splicing, bending and welding.
3. Installation instructions including allowable temperature ranges at time of joint construction.

B. Shop Drawings: Submit shop drawings showing types and configurations of compression seals selected, with supporting calculations demonstrating conformance with indicated design criteria.

C. Certificates: Provide manufacturer's certificate complying with requirements of Part 1 "Quality Assurance" Article.

1.04 QUALITY ASSURANCE

A. Certificates: Provide certificate listing materials used in accepted manufacturer's systems and certifying compliance with standards designated and design criteria indicated.

1.05 JOB CONDITIONS

A. Environmental Requirements. Do not install compression sealing systems when temperature is above 85 degrees or below 40 degrees F. or when there is ice, frost, or dampness on the surfaces to be sealed.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Preformed Compression Seals: ASTM D 2628, dimensions and configuration selected by manufacturer to meet the indicated design criteria, continuous one-piece construction except at following locations:

1. At 90 degrees corners.
2. At intersections of compression seals.
3. At other locations accepted by the Engineer.

B. Lubricant-Adhesive: Compound consisting of same base polymer as seals, blended with suitable volatile solvents, having suitable consistency at temperatures at which seals are to be installed and compatible with materials abutting seals.

C. Compression Seal Joint Material: Closed cell neoprene, conforming to ASTM C 509, with adhesive as recommended by manufacturer.

D. Bonding Adhesive for Compression Seal Intersections: As recommended by manufacturer.

E. Ferrous Metal: Section 05500 - MISCELLANEOUS METALS.

F. Aluminum Extrusions: ASTM B 221, clear anodized.

G. Fastenings For Mechanical Lock Type Seals: Types as indicated, conforming to Section 05500 - MISCELLANEOUS METALS.

H. Stainless Steel Material: Bar ASTM A167, Countersunk Bolts ASTM A193, Grade BB

I. Strip Seal Bladder – ASTM 3542

J. Steel Extrusions – ASTM A709 – Grade 36

2.02 FINISHES

A. Ferrous Metal

1. Mild Steel: Clean, and zinc coat in accordance with applicable requirements of Section 05500 - MISCELLANEOUS METALS .
2. Corrosion Resisting: Manufacturer's standard.

B. Aluminum: Aluminum Association designated finish as specified.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean out joints to receive compression seals in a manner that leaves joint walls clean and joints free of debris and moisture.

B. Patch interfaces, edges, and corners of joints as required to provide smooth, straight, and parallel sides to proper width and depth as required for proper installation of compression seals.

3.02 INSTALLATION

A. Compression Seal Joints

1. General. Install seal joints in accordance with following requirements:
   a. At 90 Degree Corners: At end of each compression seal.
   b. At Compression Seal Intersections: At end of shorter compression seal or seals.
   c. At Locations Accepted by the Engineer: As required to close ends of compression seals, unless otherwise directed.
2. Installation of Seal Joints
   a. Cut joint seals to thickness as recommended by manufacturer and equal to size and shape of uncompressed seal.
   b. Install joint seals on open end of compression seal with joint seal adhesive applied in accordance with manufacturer's instructions.
3. Dimensional Requirements. Provide compression seals having joint seals such that length of compression seal plus joint seal or seals is as required to provide, upon installation, joint seals in compression in accordance with manufacturer's recommendations.

B. Installation of Non-Mechanical Type Seals

1. Apply continuous coat of lubricant-adhesive to both sides of joints to entire depth of compression seals, and to edges of compression seals designed to be in contact with sides of joints.
2. While lubricant-adhesive is still wet, install compression seals to required depth.

C. Installation of Mechanical Lock Type Systems

1. Install seal and assemblies as indicated.
2. Install aluminum or steel facings or claws continuous for the full length of joints where indicated. Where splicing is required, provide continuous welded joint, ground smooth.

D. Splicing. If permitted by the Engineer, perform splicing in accordance with manufacturer's instructions.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Compression seals will be measured as per linear foot complete in place, including all preparation, accessories, submittals, labor, materials, equipment, and incidentals to the complete the work to the satisfaction of the engineer.

B. Expansion Joints at Columbia Road Bridge Piers will be measured as per linear foot complete in place under Item 0513.170 Expansion Joint, including all Stainless Steel fittings, bolt, screws and plates Strip Seal Bladder and Strip Extrusions, including all steel preparations, coordination, submittals, labor, materials equipment, accessories and incidentals to the complete the work to the satisfaction of the engineer.

4.02 PAYMENT

A. Payment for Expansion Joint, Item 0513.170, will be made at the Contract unit price for the quantities as specified above.

B. Payment for Compression Seals, Item 0790.111, will be made at the Contract unit price for the quantities as specified above.

4.03 PAYMENT ITEMS

Item no.	Description	Unit
0513.170	Expansion Joint	LF
0790.111	Compression Seals	LF

END OF SECTION

SECTION 07920

JOINT SEALANTS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies the following:

1. Joint sealants and fillers for interior and exterior applications.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 04800 - MASONRY: Masonry control and expansion joint fillers and gaskets.
2. Section 08801 - GLASS AND GLAZING: Glazing sealants.

1.2 PERFORMANCE REQUIREMENTS

A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.3 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch wide joints formed between two 6-inch long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

C. Qualification Data: For Installer.

D. Preconstruction Field Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on preconstruction testing specified in Part 1 "Quality Assurance" Article.

E. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

F. Field Test Report Log: For each elastomeric sealant application.

G. Product Test Reports: Based on comprehensive testing of product formulations performed by a qualified testing agency, indicating that sealants comply with requirements.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized Installer who is approved or licensed for installation of elastomeric sealants required for this Project.

B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

C. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Use manufacturer's standard test method to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
3. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
4. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

D. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to Project joint substrates as follows:

1. Locate test joints where indicated on Project or, if not indicated, as directed by Engineer.
2. Conduct field tests for each application indicated below:
   a. Each type of elastomeric sealant and joint substrate indicated.
   b. Each type of nonelastomeric sealant and joint substrate indicated.

3. Notify Engineer seven days in advance of dates and times when test joints will be erected.
   a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193.
      1. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

4. Report whether sealant in joint connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
5. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1.

1.5 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than or greater than those allowed by joint-sealant manufacturer for applications indicated.
4. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.
5. When substrates have not cured sufficiently.

1.6 WARRANTY

A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

C. Special warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:

1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
2. Disintegration of joint substrates from natural causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Provide interior sealants and sealant primers that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

C. Colors of Exposed Joint Sealants: As indicated by manufacturer's designations.

2.2 JOINT SEALANTS

A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

B. Stain-Test-Response Characteristics: Elastomeric sealants shall be nonstaining to porous substrates. Provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

C. Suitability for Contact with Food: Where elastomeric sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

D. Single-Component Neutral-Curing Silicone Sealant:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   a. Dow Corning Corporation; 790.
   b. GE Silicones; SilPruf LM SCS2700.
   c. Tremco; Spectrem 1.
   d. Pecora Corporation; 864.

2. Extent of Use: Joints in exterior vertical and soffit surfaces.

E. Multicomponent Pourable Urethane Sealant:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   a. Bostik Findley; Chem-Calk 550.
   b. Meadows, W. R., Inc.; POURTHANE.
   c. Pecora Corporation; Urexpan NR-200.
   d. Tremco; THC-901.

2. Extent of Use: Joints in exterior horizontal surfaces.

F. Single-Component Mildew-Resistant Acid-Curing Silicone Sealant:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   a. Dow Corning Corporation; 786 Mildew Resistant.
   b. GE Silicones; Sanitary SCS1700.
   c. Tremco; Tremsil 200.

2. Extent of Use: Sanitary joints at toilet rooms.

G. Latex Sealant: Comply with ASTM C 834, Type P, Grade NF.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   a. Bostik Findley; Chem-Calk 600.
   b. Pecora Corporation; AC-20+.
   c. Sonneborn, Division of ChemRex Inc.; Sonolac.
   d. Tremco; Tremflex 834.

2.3 JOINT-SEALANT BACKING

A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin). O (open-cell material). B (bicellular material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:

C. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26 deg F. Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and to otherwise contribute to optimum sealant performance.

D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.4 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include concrete, masonry and unglazed surfaces of ceramic tile.
3. Remove laitance and form-release agents from concrete.
4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following metal, glass, porcelain enamel and glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates, where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove excess material.
4. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
4. Install in uniform continuous ribbons without gaps or air pockets.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

3.4 REPAIR AND CLEANING

A. Remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

B. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Joint sealants will be measured as per linear foot complete in place, including all preparation, accessories and incidentals.

4.2 PAYMENT

A. Payment for joint sealants will be made at the Contract unit price for the quantities as specified above.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0790.054	JOINT SEALANTS	LF

END OF SECTION

SECTION 08111

STEEL DOORS AND FRAMES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies the following items.

1. Standard hollow-metal steel doors.
2. Standard hollow-metal steel frames.

B. Items To Be Furnished Only: Furnish the following items for installation by the designated Sections

1. Section 04800 - MASONRY:
   a. Hollow metal frames in masonry openings.

C. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 04800 – MASONRY; building anchors into and grouting steel frames in masonry construction.
2. Section 08711 – DOOR HARDWARE; door hardware for steel doors.
3. Section 08801 – GLASS AND GLAZING; glazed lites.
4. Section 09900 – PAINTING; field painting steel doors and frames.

1.2 SUBMITTALS

A. Product Data: Include construction details, material descriptions, core descriptions, label compliance, fire-resistance rating, and finishes for each type of steel door and frame specified.

B. Shop Drawings: In addition to requirements below, provide a schedule of standard steel doors and frames using same reference numbers for details and openings as those on Drawings:

1. Elevations of each door design.
2. Details of doors, including vertical and horizontal edge details.
3. Frame details for each frame type, including dimensioned profiles.
4. Details and locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, accessories, joints, and connections.
7. Details of glazing frames and stops showing glazing.
8. Details of conduit and preparations for electrified door hardware and controls.

C. Qualification Data: For Installer.

D. Product Test Reports: Based on evaluation of comprehensive fire tests performed by a qualified testing agency, for each type of standard steel door and frame.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Source Limitations: Obtain standard steel doors and frames through one source from a single manufacturer.

C. Fire-Rated Door, Sidelight and Transom Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic. Provide additional protection to prevent damage to finish of factory-finished doors and frames.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store doors and frames under cover at Project site. Place units in a vertical position with heads up, spaced by blocking, on minimum 4-inch-high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber. If wrappers on doors become wet, remove cartons immediately. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating standard steel frames without field measurements. Coordinate wall construction to ensure that actual opening dimensions correspond to established dimensions.

1.6 COORDINATION

A. Coordinate installation of anchorages for standard steel frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Amweld Building Products, LLC.
2. Ceco Door Products; an ASSA ABLOY Group Company.
3. CURRIES Company; an ASSA ABLOY Group Company.
4. Mesker Door Inc.
5. Pioneer Industries, Inc.
6. Republic Builders Products Company.

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum A40 zinc-iron-alloy (galvannealed) coating designation.

D. Supports and Anchors: After fabricating, galvanize units to be built into exterior walls according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts, and Fasteners: Provide items to be built into exterior walls, hot-dip galvanized according to ASTM A 153/A 153M.

F. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching standard steel door frames of type indicated.

G. Grout: Comply with ASTM C 476, 3,000 psi with a slump of 4 inches for standard steel door frames built into concrete or masonry, as measured according to ASTM C 143/C 143M.

H. Glazing: Comply with requirements in Section 08801 – GLASS AND GLAZING.

I. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 STANDARD STEEL DOORS

A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces, unless otherwise indicated. Comply with ANSI A250.8.

1. Design: Flush panel.
2. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, mineral-board, or vertical steel-stiffener core that produces doors complying with ANSI A250.8.

    a. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.
    b. Thermal-Rated (Insulated) Exterior Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 4.0 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.
3. Top and Bottom Edges: Closed with flush or inverted 0.042-inch-thick end closures or channels of same material as face sheets.
4. Tolerances: Comply with Steel Door Institute, SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

B. Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. Provide doors complying with requirements indicated below by referencing ANSI A250.8 for level and model and ANSI A250.4 for physical-endurance level:

1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 2 (Seamless), 1-3/4 inches thick.

C. Interior Doors: Face sheets fabricated from cold-rolled steel sheet, unless otherwise indicated to comply with exterior door requirements. Provide doors complying with requirements indicated below by referencing ANSI A250.8 for level and model and ANSI A250.4 for physical-endurance level:

1. Level 2 and Physical Performance Level B (Heavy Duty), Model 2 (Seamless), 1-3/4 inches thick.

D. Hardware Reinforcement: Fabricate reinforcement plates from same material as door face sheets to comply with the following minimum sizes:

1. Hinges: Minimum 0.123 inch thick by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
2. Pivots: Minimum 0.167 inch thick by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
3. Lock Face. Closers, and Concealed Holders: Minimum 0.067 inch thick.
4. All Other Surface-Mounted Hardware: Minimum 0.067 inch thick.

E. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.4 STANDARD STEEL FRAMES

A. General: Comply with ANSI A250.8 and with details indicated for type and profile.

B. Exterior Frames: Fabricated from metallic-coated steel sheet.

1. Fabricate frames with mitered or coped and welded face corners and seamless face joints.

2. Frames for Level 3 Steel Doors: 0.067-inch-thick steel sheet.

C. Interior Frames: Fabricated from cold-rolled steel sheet, unless otherwise indicated to comply with exterior frame requirements.

1. Fabricate frames with mitered or coped and welded face corners and seamless face joints.
2. Frames for Level 2 Steel Doors: 0.053-inch-thick steel sheet.

D. Hardware Reinforcement: Fabricate reinforcement plates from same material as frames to comply with the following minimum sizes:

1. Hinges: Minimum 0.123 inch thick by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
2. Pivots: Minimum 0.167 inch thick by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
3. Lock Face, Flush Bolts, Closers, and Concealed Holders: Minimum 0.067 inch thick.
4. All Other Surface-Mounted Hardware: Minimum 0.067 inch thick.

E. Supports and Anchors: Fabricated from electrolytic zinc-coated or metallic-coated steel sheet.

F. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.
3. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch-diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

G. Floor Anchors: Formed from same material as frames, not less than 0.042 inch thick, and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.

H. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.5 STOPS AND MOLDINGS

A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, fabricated from same material as door face sheet in which they are installed.

B. Fixed Frame Moldings: Formed integral with standard steel frames, minimum 5/8 inch high, unless otherwise indicated.

C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch thick, fabricated from same material as frames in which they are installed.

2.6 FABRICATION

A. General: Fabricate standard steel doors and frames to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Standard Steel Doors:

1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
2. Glazed Lites: Factory cut openings in doors.

C. Standard Steel Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
2. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints; fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
3. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners, unless otherwise indicated.
4. Plaster Guards: Weld guards to frame at back of hardware mortises in frames installed in concrete or masonry.
5. Where installed in masonry, leave vertical mullions in frames open at top for grouting.
6. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
7. Jamb Anchors: Provide number and spacing of anchors as follows:

   a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

      1) Two anchors per jamb up to 60 inches in height.
      2) Three anchors per jamb from 60 to 90 inches in height.
      3) Four anchors per jamb from 90 to 120 inches in height.
      4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof more than 120 inches in height.

   b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

      1) Three anchors per jamb up to 60 inches in height.
      2) Four anchors per jamb from 60 to 90 inches in height.
      3) Five anchors per jamb from 90 to 96 inches in height.

4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof more than 96 inches in height.
5) Two anchors per head for frames more than 42 inches wide and mounted in metal-stud partitions.

c. Compression Type: Not less than two anchors in each jamb.
d. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.

8. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Provide plastic plugs to keep holes clear during construction.

a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

D. Hardware Preparation: Factory prepare standard steel doors and frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in Section 08711 - DOOR HARDWARE.

1. Reinforce doors and frames to receive nontemplated mortised and surface-mounted door hardware.
2. Comply with applicable requirements in ANSI A250.6 and ANSI/DHI A115 Series specifications for door and frame preparation for hardware. Locate hardware as indicated on Shop Drawings or, if not indicated, according to ANSI A250.8.

E. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of door or frame.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings such that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
4. Provide loose stops and moldings on inside of doors and frames.
5. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

2.7 STEEL FINISHES

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Finish standard steel door and frames after assembly.

B. Metallic-Coated Steel Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.

1. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

C. Steel Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning"; remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel; comply with SSPC-SP 3, "Power Tool Cleaning," or SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

D. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 0.7 mils.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied finish paint system indicated; and providing a sound foundation for field-applied topcoats despite prolonged exposure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of standard steel doors and frames.

1. Examine roughing-in for embedded and built-in anchors to verify actual locations of standard steel frame connections before frame installation.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory.

B. Prior to installation and with installation spreaders in place, adjust and securely brace standard steel door frames for squareness, alignment, twist, and plumb to the following tolerances:

1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.

C. Drill and tap doors and frames to receive nontemplated mortised and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Provide doors and frames of sizes, thicknesses, and designs indicated. Install standard steel doors and frames plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Standard Steel Frames: Install standard steel frames for doors, sidelights, transoms, borrowed lights and other openings, of size and profile indicated. Comply with SDI 105.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

    a. At fire-protection-rated openings, install frames according to NFPA 80.
    b. Where frames are fabricated in sections due to shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
    c. Install frames with removable glazing stops located on secure side of opening.
    d. Install door silencers in frames before grouting.
    e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
    f. Check plumb, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
    g. Apply bituminous coating to backs of frames that are filled with mortar, and grout.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor and secure with postinstalled expansion anchors.

    a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar as specified in Section 04800 - MASONRY,
5. Concrete Walls: Solidly fill space between frames and concrete with grout. Install grout in lifts and take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
7. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
8. Ceiling Struts: Extend struts vertically from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable wedged or bolted anchorage to frame jamb members.
9. Installation Tolerances: Adjust standard steel door frames for squareness, alignment, twist, and plumb to the following tolerances:

a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Standard Steel Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Standard Steel Doors:

   a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
   b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
   c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
   d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
3. Smoke-Control Doors: Install doors according to NFPA 105.

D. Glazing: Comply with installation requirements in Section 08801 – GLASS AND GLAZING and with standard steel door and frame manufacturer's written instructions. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c., and not more than 2 inches o.c. from each corner.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including standard steel doors or frames that are warped, bowed, or otherwise unacceptable to the Engineer.

B. Clean grout and other bonding material off standard steel doors and frames immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Steel doors and frames will be measured as per each complete in place, including all preparation, hardware, accessories and incidentals.

4.2 PAYMENT

A. Payment for steel doors and frames will be made at the Contract unit price for the quantities as specified above.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0810.002	METAL DOORS AND FRAMES	EA

END OF SECTION

SECTION 08711

DOOR HARDWARE

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies commercial door hardware.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 08111 – STEEL DOORS AND FRAMES

1.2 SUBMITTALS

A. Product Data: Include installation details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Details of electrified door hardware, indicating the following:

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring. Include the following:

    a. System schematic.
    b. Point-to-point wiring diagram.
    c. Riser diagram.
    d. Elevation of each door.

2. Detail interface between electrified door hardware and fire alarm access control and building control and security systems.

C. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening.

    a. Organize door hardware sets in same order as in the Door Hardware Schedule at the end of Part 3.

3. Content: Include the following information:

a. Type, style, function, size, label, hand, and finish of each door hardware item.
b. Manufacturer of each item.
c. Fastenings and other pertinent information.
d. Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
e. Explanation of abbreviations, symbols, and codes contained in schedule.
f. Mounting locations for door hardware.
g. Door and frame sizes and materials.
h. Description of each electrified door hardware function, including location, sequence of operation, and interface with other building control systems.

1) Sequence of Operation: Include description of component functions that occur in the following situations: authorized person wants to enter; authorized person wants to exit; unauthorized person wants to enter; unauthorized person wants to exit.

4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

D. Keying Schedule: Prepared by or under the supervision of supplier, detailing the Engineer's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

E. Product Certificates: Signed by manufacturers of electrified door hardware certifying that products furnished comply with requirements.

1. Certify that door hardware approved for use on types and sizes of labeled fire doors complies with listed fire door assemblies.

F. Qualification Data: For firms and persons specified in Part 1 "Quality Assurance" Article.

1. Include lists of completed projects with project names and addresses of architects and owners, and other information specified.

G. Maintenance Data: For each type of door hardware to include in maintenance manuals specified in Division 1.

H. Warranties: Special warranties specified in this Section.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Supplier Qualifications: Door hardware supplier with warehousing facilities in Project's vicinity and who is or employs a qualified Architectural Hardware Consultant, available during

the course of the Work to consult with Contractor and Engineer about door hardware and keying.

1. Electrified Door Hardware Supplier Qualifications: An experienced door hardware supplier who has completed projects with electrified door hardware similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance, and who is acceptable to manufacturer of primary materials.

    a. Engineering Responsibility: Prepare data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

2. Scheduling Responsibility: Preparation of door hardware and keying schedules.

C. Architectural Hardware Consultant Qualifications: A person who is currently certified by the Door and Hardware Institute as an Architectural Hardware Consultant and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.

1. Electrified Door Hardware Qualifications: Experienced in providing consulting services for electrified door hardware installations.

D. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.

1. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that are listed to perform electrical modifications, by a testing and inspecting agency acceptable to authorities having jurisdiction, are acceptable.

E. Regulatory Requirements: Comply with provisions of the following:

1. Where indicated to comply with accessibility requirements, comply with Massachusetts Architectural Access Board and the Americans with Disabilities Act (ADA), "Accessibility Guidelines for Buildings and Facilities (ADAAG)," as follows:

    a. Handles, Pulls, Latches, Locks, and other Operating Devices: Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.
    b. Door Closers: Comply with the following maximum opening-force requirements indicated:

        1) Interior Hinged Doors: 5 lbf applied perpendicular to door.
        2) Sliding or Folding Doors: 5 lbf applied parallel to door at latch.
        3) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

    c. Thresholds: Not more than 1/2 inch high. Bevel raised thresholds with a slope of not more than 1:2.

2. NFPA 101: Comply with the following for means of egress doors:

   a. Latches, Locks, and Exit Devices: Not more than 15 lbf to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.
   b. Delayed-Egress Locks: Lock releases within 15 seconds after applying a force of not more than 15 lbf for not more than 3 seconds.
   c. Door Closers: Not more than 30 lbf to set door in motion and not more than 15 lbf (67 N) to open door to minimum required width.
   d. Thresholds: Not more than 1/2 inch high.

3. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

F. Fire-Rated Door Assemblies: Provide door hardware for assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.

1. Test Pressure: Test at atmospheric pressure.

G. Keying Conference: Conduct conference at Project site to comply with requirements in Division 1. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:

1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
2. Preliminary key system schematic diagram.
3. Requirements for key control system.
4. Address for delivery of keys.

H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1. Review methods and procedures related to electrified door hardware including, but not limited to, the following:

1. Inspect and discuss electrical roughing-in and other preparatory work performed by other trades.
2. Review sequence of operation for each type of electrified door hardware.
3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review required testing, inspecting, and certifying procedures.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver keys to manufacturer of key control system.

1.5 COORDINATION

A. Coordinate layout and installation of recessed pivots and closers with floor construction. Cast anchoring inserts into concrete. Concrete, reinforcement, and formwork requirements are specified in Section 03300 - CAST-IN-PLACE CONCRETE.

B. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

C. Electrical System Roughing-in: Coordinate layout and installation of electrified door hardware with connections to power supplies, fire alarm system and detection devices, access control and building control system.

1.6 WARRANTY

A. General Warranty: Special warranties specified in this Article shall not deprive the Authority of other rights the Authority may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of operators and door hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

C. Warranty Period: Three years from date of Substantial Completion, unless otherwise indicated.

D. Warranty Period for Manual Closers: Ten years from date of Substantial Completion.

1.7 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for the Authority's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. Scheduled and acceptable manufacturers must provide all the functions and features of the specified product or it will not be approved.

Item	Scheduled Manufacturer	Acceptable Manufacturers
Hinges	Ives (IVE)	McKinney, Hager
Continuous Hinges	Markar (MAR)	Stanley, McKinney
Locksets & Deadlocks	Schlage (SCH)	Sargent, Best
Keypad Locks	Schlage (SCH)	Campus Standard
Cylinders & Keying	Schlage (SCH)	Campus Standard
Exit Devices & Mullions	Von Duprin (VON)	Precision, Sargent
Door Closers & Auto Operators	LCN (LCN)	Norton, Sargent
Push & Pull Plates & Bars	Ives (IVE)	Rockwood, Burns
Flush Bolts & Coordinators	Ives (IVE)	Rockwood, Burns
Protection Plates	Ives (IVE)	Rockwood, Burns
Stops & Holders	Ives (IVE)	Rockwood, Burns
Overhead Stops	Glynn-Johnson (GLY)	Sargent, Rixson
Silencers	Ives (IVE)	Rockwood, Burns
Thresholds & Weather-strip	National Guard (NGP)	Pemko, Reese

B. Hand of Door: Drawings show direction of slide, swing, or hand of each door leaf. Furnish each item of hardware for proper installation and operation of door movement as shown.

C. Where the hardware specified is not adaptable to the finished shape or size of the members requiring hardware, furnish suitable types having the same operation and quality as the type specified, subject to the Engineer's approval.

2.2 MATERIALS

A. Fasteners

1. Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation.

2. Furnish non-corrosive screws for installation with each hardware item. Finish exposed (exposed under any condition) screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work as closely as possible including "prepared for paint" surfaces to receive painted finish.
3. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent that no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless their use is the only means of reinforcing the work adequately to fasten the hardware securely.
4. All hardware shall be installed with the fasteners provided by the hardware manufacturer.

B. Hinges

1. The following is a guide for hinge type required for this specification:
   a. 1 3/4" thick doors up to and including 3'-0" wide:
      exterior: standard weight, ball bearing, bronze/stainless steel, 4 1/2" high
      interior: standard weight, ball bearing, steel, 4 1/2" high
   b. 1 3/4" thick doors over 3'-0" wide:
      exterior: heavy weight, ball bearing, bronze/stainless steel, 5" high
      interior: heavy weight, ball bearing, steel, 5" high
2. Provide 3 hinges per door leaf for doors 90 inches or less in height, and one additional hinge for each 30 inches of additional door height.
3. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
   a. Steel Hinges: Steel pins
   b. Non-Ferrous Hinges: Stainless steel pins
   c. Out-Swinging Exterior Doors: Non-removable pins
   d. Interior Doors: Non-rising pins
4. The width of hinges shall be 4 1/2" or as required for clearance.

C. Continuous Hinges

1. Provide continuous hinges fabricated from anodized aluminum or stainless steel as scheduled.
2. Provide bearings at each hinge knuckle for quiet, smooth, self-lubricating operation.
3. Hinges shall be capable of supporting door weights up to 600 pounds, and shall be successfully tested for 1,500,000 cycles.
4. Install hinges with fasteners supplied by manufacturer. Hole pattern shall be symmetrically patterned.

D. Flush Bolts

1. Automatic and manual flush bolts shall have forged bronze faceplates with extruded brass levers and with wrought brass guides and strikes. Doors up to 7'-6" in height shall have 12" steel or brass rods. Manual flush bolts for doors over 7'-6" in height shall be increased by 6" for each additional 6" of door height. Provide dust-proof strikes where scheduled.

E. Coordinators

1. Where pairs of doors are equipped with automatic flush bolts, an astragal, or other hardware that requires synchronized closing of the doors, provide a bar-type coordinating device, surface applied to the underside of the stop at the frame head.

2. Finish of the coordinator to be prime coat to receive the same finish paint as the door frame.
3. Provide a filler bar of the correct length for the unit to span the entire width of the opening, and appropriate brackets for parallel arm door closers and surface vertical rod exit device strikes. Factory-prep coordinators for vertical rod devices if required.

F. Mortise Locks

1. Mortise locks shall be certified as ANSI A156.13, Grade 1 Operational, Grade 1 Security, and shall be manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance. Lock case shall be multi-function and field reversible for handing without opening the case.
2. Locks are to have a standard 2 3/4" backset with a full 3/4" throw 2-piece stainless steel mechanical anti-friction latchbolt. Deadbolt shall be a full 1" throw, constructed of stainless steel.
3. Lever trim shall be solid brass, bronze, or stainless steel, cast or forged in the design specified, with wrought roses and external lever spring cages. Levers shall be thru-bolted to assure proper alignment, and shall have a 2-piece spindle. Lever trim on the secure side of doors serving rooms considered by the authority having jurisdiction to be hazardous shall have a tactile warning. Lever design shall be Schlage 17A or similar.
4. Locks meeting this specification: Schlage L9000 series, Sargent 8200 series, Best 35H series.

G. Keypad Locks

1. Locksets shall be mortise type with 3-piece, beveled, stainless steel latchbolts with 3/4" throw and equipped with an anti-friction latch.
2. Chassis shall accommodate ANSI standard mortise lock prep with a 2 3/4" nominal backset for 1 3/4" doors.
3. Locksets shall be provided from the factory with appropriate handing.
4. Levers shall operate independently of each other. Lock shall use patented clutch mechanism to deter vandalism and maximize durability. Disablement of secured levers shall not permit latchbolt retraction from secure side, but shall allow egress. Lever trim on the secure side of doors serving rooms considered by the authority having jurisdiction to be hazardous, or where noted on the door schedule, shall be knurled to provide a tactile warning. Lever style to be Schlage 17.
5. Provide key cylinder for emergency key override, with Everest/Primus core.
6. Electrical operation shall be battery operated, capable of 80,000 operating cycles using four AA alkaline batteries. Lock shall be resistant to radio frequency and electrostatic discharge.
7. Outside escutcheon shall have keypad and iButton reader.
8. Visual red and green LED indicators shall indicate activation, operational systems status, system error conditions and low power conditions.
9. Locks meeting this specification: Schlage/Locknetics CM5596.

H. Exit Devices

1. Exit devices shall be touchpad type, fabricated of brass, bronze, stainless steel, or aluminum, plated to the standard architectural finishes to match the balance of the door hardware.
2. All exit devices shall incorporate a fluid damper or other device which eliminates noise associated with exit device operation. Touchpad shall extend a minimum of one half of the door width. End-cap will have two-point attachment to door. Touch-pad shall match exit device finish, and shall be stainless steel for US26, US26D, US28, US32, and US32D fin-

ishes. Only compression springs will be used in devices, latches, and outside trims or controls.

3. All devices to incorporate a security deadlatching feature.
4. Provide roller strikes for all rim and surface mounted vertical rod devices, ASA strikes for mortise devices, and manufacturer's standard strikes for concealed vertical rod devices.
5. Mechanism case shall sit flush on the face of all flush doors, or spacers shall be furnished to fill gaps behind devices. Where glass trim or molding projects off the face of the door, provide glass bead kits.
6. All non-fire-rated exit devices shall have cylinder dogging.
7. Where lever handles are specified as outside trim for exit devices, provide heavy duty lever trims with forged or cast escutcheon plates. Provide vandal-resistant levers that will travel to a 90-degree down position when more than 35 pounds of torque are applied, and which can easily be re-set. Lever style will match the lever style of the locksets.
8. Exit devices shall be UL listed panic exit hardware. All exit devices for fire rated openings shall be UL labeled fire exit hardware.
9. Provide electrical options as scheduled.
10. Exit devices meeting this specification: Von Duprin 98 series, Precision D-1100/D-1200 series, Sargent 80 series with deadlatching.

I. Door Closers

1. Door closers shall have fully hydraulic, full rack and pinion action with a high strength cast iron or cast aluminum cylinder. Cylinder body shall be 1 1/2" in diameter, and double heat-treated pinion shall be 11/16" in diameter.
2. Hydraulic fluid shall be of a type requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F. Fluid shall be fireproof and shall pass the requirements of the UL10C "positive pressure" fire test.
3. Spring power shall be continuously adjustable over the full range of closer sizes, and allow for reduced opening force for the physically handicapped. Hydraulic regulation shall be by tamper-proof, non-critical valves. Closers shall have separate adjustment for latch speed, general speed, and backcheck.
4. All closers shall have solid forged steel main arms (and forged forearms for parallel arm closers).
5. Closers shall not incorporate a pressure relief valve.
6. All closers shall have metal covers.
7. Closer cylinders, arms, and metal covers shall have a powder coating finish which has been certified to exceed 100 hours salt spray testing by an independent testing laboratory used by BHMA for ANSI certification. For metal components that can't be powder coated, a special rust inhibiting finish (SRI) must be used.
8. Door closers meeting this specification: LCN 4010/4110 series, Norton 7500/PR7560 (standard screws).

J. Push Plates: 8" wide x 16" high x .050" thick. Where door stile does not allow 8" wide plates, 4" wide plates may be used.

K. Door Pulls & Push Bars: Solid bar stock, diameter and length as scheduled. Push bars shall be of sufficient length to span from center to center of each stile.

L. Protection Plates: Provide kick plates as scheduled, with 4 beveled edges. Furnish with machine or wood screws, finished to match plates. Plates shall be 8" high x 2" LWOD on single doors, 1" LWOD on pairs of doors.

M. Door Stops and Holders

1. It shall be the responsibility of the hardware supplier to provide door stops for all doors in accordance with the following requirements:
   a. Wall stops shall be used wherever possible.
   b. Where wall stops cannot be used, provide dome type floor stops of the proper height.
   c. At any opening where a wall or floor stop cannot be used, a heavy duty overhead stop must be used.

N. Thresholds and Weatherstrip: Furnish as scheduled and per architectural details. Match finish of other items as closely as possible. Provide only those units where resilient or flexible seal strip is easily replaceable and readily available.

O. Silencers: "Push-in" type silencers for each hollow metal or wood frame, 3 for each single frame, 2 for each pair frame. Omit where gasketing is scheduled.

P. Automatic Operators:

1. Where low kinetic energy, as defined by ANSI Standard A156.19, power operators are indicated for doors required to be accessible to the disabled, provide pneumatically powered operators complying with the 1990 ADA guidelines for opening force and time to close standards.
2. Full closing force shall be provided when the power operation cycle ends.
3. Locate power unit and exhaust away from door to minimize noise and vibration in pedestrian areas.
4. All power operator systems shall include the following features and functions:
   a. Provisions for separate conduits to carry high and low voltage wiring in compliance with the National Electric Code, section 725-31.
   b. When an obstruction or resistance to the opening swing is encountered, the operator will continue attempting to open the door. If the obstruction or resistance remains, the operator will again pause the door.
   c. The operator will be designed to prevent damage to the mechanism if the system is actuated while the door is latched or if the door is forced closed during the opening cycle.
5. All covers, mounting plates, and arm systems shall be powder coated and successfully pass a minimum of 100 hours of salt-spray testing as outlined in ANSI Standard A156.18.
6. All operators shall be non-handed with spring power over a range of at least four sizes; either 1 through 4 or 2 through 5.
7. Provisions in the control box or module shall provide control (inputs and outputs) for; electric strike delay, auxiliary contacts, sequential operation, fire alarm systems, actuators, swing side sensors, and stop side sensors.
8. Automatic operators meeting this specification: LCN 2600 Series.

2.3 FINISHES

A. With the exception of all items listed below, the finish of all hardware shall be US26D - satin chrome or US32D - satin stainless steel.

B. Exceptions are as follows:
1. Door Closers - aluminum powder coat finish.

2. Coordinators - prime painted.
3. Thresholds - mill finish aluminum.
4. Weatherstrip & Sweeps - clear anodized aluminum.
5. Silencers - grey.

2.4 KEYING

A. All locks and cylinders shall be construction master keyed and master keyed per the Authority's instructions, to existing key system.

B. All locks and cylinders, except cylinders for keypad locks will be interchangeable core type.

C. Provide 3 keys per lock, 6 construction master keys, and a total of 6 master keys for each group.

D. All master keys shall be delivered directly to the Authority by the hardware supplier, who shall obtain a receipt for delivery of same.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Steel Doors and Frames: Comply with DHI A115 series.

1. Surface-Applied Door Hardware: Drill and tap doors and frames according to SDI 107.

B. Wood Doors: Comply with DHI A115-W series.

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. Key Control System: Place keys on markers and hooks in key control system cabinet, as determined by final keying schedule.

D. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings. Verify location with Engineer.

1. Configuration: Provide the least number of power supplies required to adequately serve doors with electrified door hardware.

E. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Section 07920 - JOINT SEALANTS.

3.4 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.
2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
3. Door Closers: Adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.

B. Six-Month Adjustment: Six months after date of Substantial Completion, Installer shall perform the following:

1. Examine and readjust each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.
2. Consult with and instruct the Authority's personnel on recommended maintenance procedures.
3. Replace door hardware items that have deteriorated or failed due to faulty design, materials, or installation of door hardware units.

3.5 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT AND PAYMENT

A. No separate measurement or payment will be made for work required under this Section. All costs in connection therewith shall be considered incidental to the item or items of work to which they pertain.

END OF SECTION

SECTION 08801

GLASS AND GLAZING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies the following items.

1. Glass and glazing for the following products and applications:
   a. Tempered safety laminated glass panels at station signage Type B
   b. Tempered safety laminated glass panels at the pedestrain overpass and access ramps

B. Related Work: None

1.2 DEFINITIONS

A. Manufacturers of Glass Products: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. Deterioration of Coated Glass: Defects developed from normal uses that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.

D. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

E. Deterioration of Laminated Glass: Defects developed from normal uses that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1.3 PERFORMANCE REQUIREMENTS

A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in

the thickness designations indicated for various size panels, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:

1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:
   a. Specified Design Wind Loads: As required by Code.
   b. Specified Design Snow Loads for Sloped Glazing: As required by Code.
   c. Probability of Breakage for Vertical Glazing: 8 lites per 1000 for lites set vertically or not more than 15 degrees off vertical and under wind action.
      1) Load Duration: 60 seconds minimum.
   d. Probability of Breakage for Sloped Glazing: 1 lite per 1000 for lites set more than 15 degrees off vertical and under wind and snow action.
      1) Load Duration: 30 days minimum.
   e. Maximum Lateral Deflection: For the following types of glass supported on all 4 edges, provide thickness required that limits center deflection at design wind pressure to 1/50 times the short side length or 1 inch, whichever is less.
      1) For monolithic-glass lites heat treated to resist wind loads.
      2) For laminated-glass lites.
   f. Minimum Glass Thickness for Exterior Lites: Not less than 6 mm.

C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

D. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:

1. For monolithic-glass lites, properties are based on units with lites 6.0 mm thick.
2. For laminated-glass lites, properties are based on products of construction indicated.

1.4 SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. Samples: For the following products, in the form of 12-inch- square Samples for glass.

1. Each color of tinted float glass.
2. Each type of patterned glass.
3. Coated vision glass.
4. Ceramic-coated spandrel glass.
5. Each pattern and color of ceramic-coated vision glass.
6. Wired glass.
7. Fire-resistive glazing products.
8. Each type of laminated glass with colored or translucent interlayer.
9. Insulating glass for each designation indicated.
10. For each color (except black) of exposed glazing sealant indicated.

C. Glazing Schedule: Use same designations indicated on Drawings in preparing a schedule listing glass types and thicknesses for each size and location.

D. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.

E. Qualification Data: For installers, in accordance with Par. 1.5A.

F. Preconstruction Adhesion and Compatibility Test Report: From glazing sealant manufacturer indicating glazing sealants were tested for adhesion to glass and glazing channel substrates and for compatibility with glass and other glazing materials.

G. Product Test Reports: For each of the following types of glazing products:

1. Tinted float glass.
2. Coated float glass.
3. Insulating glass.
4. Glazing sealants.
5. Glazing gaskets.

H. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer with a minimum of three years experience who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance.

B. Source Limitations for Glass: Obtain the following through one source from a single manufacturer for each glass type: clear float glass, laminated glass and insulating glass.

C. Source Limitations for Glazing Accessories: Obtain glazing accessories through one source from a single manufacturer for each product and installation method indicated.

D. Elastomeric Glazing Sealant Product Testing: Obtain sealant test results for product test reports in Part 1 "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period.

1. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.
2. Test elastomeric glazing sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.

E. Hold Point - Preconstruction Adhesion and Compatibility Testing: Submit to elastomeric glazing sealant manufacturers, for testing indicated below, samples of each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member that will contact or affect elastomeric glazing sealants:

1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
2. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.

4. For materials failing tests, obtain sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
5. Testing will not be required if elastomeric glazing sealant manufacturers submit data based on previous testing of current sealant products for adhesion to, and compatibility with, glazing materials matching those submitted.

F. Safety Glazing Products: Comply with testing requirements in 16 CFR 120.

1. Subject to compliance with requirements, obtain safety glazing products permanently marked with certification label of the Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction.
2. Where glazing units, including Kind FT glass and laminated glass, are specified in Part 2 articles for glazing lites more than 9 sq. ft. in exposed surface area of one side, provide glazing products that comply with Category II materials, for lites 9 sq. ft. or less in exposed surface area of one side, provide glazing products that comply with Category I or II materials, except for hazardous locations where Category II materials are required by 16 CFR 1201 and regulations of authorities having jurisdiction.

G. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. GANA Publications: GANA Laminated Division's "Laminated Glass Design Guide" and GANA's "Glazing Manual."
2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR-A7, "Sloped Glazing Guidelines."
3. IGMA Publication for Sloped Glazing: IGMA TB-3001 "Sloped Glazing Guidelines."

H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes. Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 deg F.

1.8 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form, made out to the Authority and signed by coated-glass manufacturer agreeing to replace coated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: Ten years from date of Substantial Completion.

B. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form, made out to the Authority and signed by laminated-glass manufacturer agreeing to replace laminated-glass units that deteriorate as defined in Part 1 "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GLAZING SEALANTS

A. General: Provide products of type indicated, complying with the following requirements:

1. Compatibility: Verify glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Colors of Exposed Glazing Sealants: As selected by Engineer from manufacturer's full range.

B. Elastomeric Glazing Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

1. Single-Component Neutral- and Basic-Curing Silicone Glazing Sealants:

   a. Dow Corning Corporation; 790.
   b. GE Silicones; SilPruf LM SCS2700.
   c. Tremco; Spectrem 1 (Basic).

2.2 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for project conditions.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive; and complying with AAMA 800 for the following types: [Frank – Type 1 is what we're identifying on drawings]

1. Type 1, for glazing applications in which tape acts as the primary sealant.
2. Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.3 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

2.4 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to glaze panels indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites in a manner that produces square edges with slight kerfs at junctions with outdoor and indoor faces.

C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing glazing, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep system.
3. Minimum required face or edge clearances.
4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50 inches as follows:

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until just before each glazing unit is installed.

F. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

3.5 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.6 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

A. Separate measurement and payment will not be made for Glass and Glazing, complete in place, but all costs in connection therefore shall be included in the Contract Unit Prices for the items of work to which it pertains.

4.2 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
1041.502	STATION SIGN – TYPE B	EA
0211.615	PEDESTRIAN OVERPASS	EA

END OF SECTION

SECTION 09360

MODULAR TACTILE SURFACES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies modular tactile surface tiles at station platforms and at curb ramps.

1. This Section includes Specifications for furnishing and installing composite wet set replaceable tactile warning surface (TWS) Units, in an in-line truncated dome pattern, embedded in all precast concrete platform panels, curb ramps and walking surfaces at the locations and to the dimensions shown on the Drawings, in accordance with the Contract Documents and as directed by the Engineer.
2. It is the responsibility of the Contractor to provide coordination between modular tactile surface manufacturer and precast platform panel precaster to ensure compatibility of the two systems.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 03300 - CAST-IN-PLACE CONCRETE
2. Section 03410 – PLANT - PRECAST STRUCTURAL CONCRETE
3. Section 07920 - JOINT SELANTS

1.2 SUBMITTALS

A. Shop Drawings: Include complete layout and fabrication details, composite structure, dimensions of tiled areas, and affected adjacent areas. Provide large scale plan details of the tiles at the curves, including fastener locations. Shop Drawings shall also show all pertinent characteristics of the composite wet set replaceable tactile warning surface unit, including profile, sound on cane contact amplification feature and installation methods.

B. Product Data: Manufacturer's catalog cuts, material specifications, installation and maintenance instructions, and other data pertinent to the work of this Section.

C. Samples: One full-size sample of the type, size, pattern, and color of tile required, and five twelve inch by twelve inch samples for MBTA records. Samples shall be properly labeled and shall contain the following information: Name of Project, Submitted by, Date of Submittal, Manufacturer's Name, and Catalog No.

D. Material Certification: Manufacturer's certification that all products meet specified requirements, as verified by a certified independent testing agency. Submit certified test reports for all tests shown in Article 2.02 B, indicating for each test whether or not the tile passes or fails the passing criteria. Test report shall be current and shall not predate the notice to proceed date of this contract by more than two years. All test reports submitted shall be representative of the tactile warning surface product delivered to the Project, and shall be no more than three (3) years old from the time of the submittal.

E. Installer Certification: Manufacturer's approval of installer if other than manufacturer, and detailed work history with the product proposed for installation.

F. Extra Materials: After completion of the work, furnish a minimum of ten percent of the total amount of tile furnished, from the same manufactured lot as materials furnished for work of this Section, in sealed, protective packaging marked with Contract number, lot number and identification contents. Store in a location designated by the Engineer.

1.3 QUALITY ASSURANCE

A. Manufacturer: A company specializing in the manufacture of modular tactile surface tiles as used in transit systems for guidance of the sight impaired. Provide composite wet set replaceable tactile warning surface units as produced by a single manufacturer.

B. Installation: Composite wet set replaceable tactile warning surface units shall be installed at the precast concrete platform panel precast shop at the time of casting.

1. All composite wet set replaceable tactile warning surface units shall be cast integrally with precast concrete platform panel flush with the finished surface of the platform panel under the supervision of a manufacturer-approved installer with documented experience in work similar to that of this Section.
2. The manufacturer-approved installation supervisor must be approved by the Engineer before installation of the tile may begin.
3. All anchorages of composite wet set replaceable tactile warning surface units shall be fully embedded into precast concrete.
4. Composite wet set replaceable tactile warning surface units shall be suspended as part of the casting process to ensure that full bond of anchorages occurs. Composite wet set replaceable tactile warning surface units shall not be "pressed" into wet concrete.

C. First Time Suppliers and Installers: For first time installers and suppliers of tactile tile to the MBTA, a meeting with representatives of the Engineer, Contractor, Surface Preparation subcontractor, Manufacturer, and Installer in attendance is mandatory. The agenda shall include the review and clarification of the specification, installation procedures, quality control, inspection and acceptance criteria and installation schedules. In no case will installation be allowed to commence until this meeting is held.

D. Hold Point - Mock-Up: After approval of materials, erect an eight foot long tile mock-up using specified materials, at a location acceptable to the Engineer.

1. Assign the same construction crew to both the mock-up and the permanent work.
2. If not approved, remove and replace mock-up at no additional cost to the Authority. Repeat procedure until approval is granted.
3. Approved mock-up shall serve as the quality standard for appearance, tolerances, and workmanship.
4. Approved mock-up may be incorporated in the permanent work, with the following certification.
5. Protect and maintain approved mock-up in accepted condition throughout the construction period. When no longer required, remove and dispose of off site, if not incorporated into the permanent work.

E. Tactile warning surface product shall meet or exceed the following test criteria using the most current test methods:

1. Water Absorption: Not to exceed 0.20%, when tested in accordance with ASTM-D570.
2. Slip Resistance: 0.80 minimum combined wet/dry static coefficient of friction when tested in accordance with ASTM C 1028.
3. Compressive Strength: 25,000 psi minimum, when tested in accordance with ASTM D695.
4. Tensile Strength: 10,000 psi minimum, when tested in accordance with ASTM D638.

5. Flexural Strength: 25,000 psi minimum, when tested in accordance with ASTM D790.
6. Chemical Stain Resistance: No reaction to 1% hydrochloric acid, motor oil, calcium chloride, gum, soap solution, bleach, and antifreeze, when tested in accordance with ASTM D543 orDl3O8.
7. Abrasion Resistance: 300 minimum, when tested in accordance with ASTM C501.
8. Flame Spread: 25 maximum, when tested in accordance with ASTM E84.
9. Accelerated Weathering of Tactile Warning Surface when tested by ASTM-G155 or ASTM G151 shall exhibit the following result: $\Delta E<5.0$ at 2,000 hours minimum exposure.
10. AASHTO-H20 Load Bearing Test: No Damage at 16,000 # loading.
11. Salt and Spray Performance of Tactile Warning Surface: No deterioration or other defects after 200 hours of exposure, when tested in accordance with ASTM-B117.

1.4 DELIVERY, STORAGE AND HANDLING

A. Composite wet set replaceable tactile warning surface units shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy wrappings.

B. Deliver materials and products in unopened, factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Store under cover and protect from all damage and pilferage

1.5 WARRANTY

A. In addition to the requirements of the General Conditions, furnish a warranty jointly executed by the tile manufacturer, the installer, and the precast concrete Precaster. The Precaster shall acknowledge, and certify that the warranty of precast concrete platform panels will not be altered on the basis of incorporation of the composite wet set replaceable tactile warning surface installation during the time of casting.

B. Composite wet set replaceable tactile warning surface units shall be guaranteed in writing for a period of five (5) years from date of Contract's final completion. The guarantee includes defective work, breakage, deformation, and loosening of tactile warning surface material. The TWS manufacturer shall also warrant and certify that the reverse profile of the TWS Unit will not change in any way for a minimum of 10 years to insure full TWS Product interchangeability

PART 2 - PRODUCTS

2.1 GENERAL

A. The modular tactile surface shall differ from adjoining surfaces in resiliency or sound-on-cane contact as set forth in the following accessibility guidelines. These references are intended to establish quality and performance characteristics and meet the legal definition of the law.
1. 28 CFR Part 36 – Appendix A: Standards for Accessible Design ADA Accessibility Guidelines for Buildings and Facilities (latest edition).
2. Massachusetts Architectural Access Board Rules and regulations (521 CMR) (latest edition).
3. Accessibility Handbook for Transit Facilities – USDOT (FTA-MA-06-0200-92-1) (DOT-VNTSC-FTA-92-4) (July 1992).
4. Commuter Rail Design Standards Manual – VOL 1, SEC 1: Track and Roadway, MBTA Railroad Operations (Rev No. 1 19 April 1996).
5. Massachusetts State Building Code (Current Edition).
6. In case of conflict between codes, standards, regulations, specifications, general notes and/or manufacturer's requirements, use the more stringent provisions.

2.2 MODULAR TACTILE SURFACE TILE

A. Accessibility Requirements: The modular tactile tile surface system shall differ from adjoining surfaces in resiliency or sound-on-cane contact as set forth by the latest requirements of the Americans with Disabilities (ADA) and the Massachusetts Architectural Access Board (AAB). Such reference is intended to establish quality and performance characteristics and meet the legal definition of the law.

B. Modular Tile: Provide fiberglass polymer platform edge surfaces with 24 in. x 48 in. sheets, as indicated on Drawings.

C. Composition: Composite wet set replaceable tactile warning surface units shall be manufactured using a matte finish exterior grade homogeneous (uniform throughout thickness of product) glass and carbon reinforced polyester based SMC composite material. Truncated domes must contain fiberglass reinforcement within the truncated dome for superior structural integrity and impact resistance. A matte finish will be required on the tactile warning surface for superior slip resistance performance superior to that offered by a gloss finish. Use of tactile warning surface products employing coatings or featuring layers of material with differing composition, performance, or color properties is expressly prohibited under this Section.

D. Color: Color shall be homogeneous throughout the composite wet set replaceable tactile warning surface units and shall be Federal Yellow per Federal Standard 595B Table IV, Color No. 33538.

E. Domes: Square grid pattern of raised truncated domes of 0.2 inches nominal height, base diameter of 0.9 inches, and top diameter of 0.45 inches. The Federal Code of Regulations permits a truncated dome spacing range of 1.6"-2.4." For superior wheelchair, walker and shopping cart mobility, truncated domes shall have a center-to-center (horizontally and vertically) spacing of 2.35 inches, measured between the most adjacent domes on square grid.

F. Configuration: Composite wet set replaceable tactile warning surface unit sizes shall be as indicated on the Contract Drawings. Replaceable tactile warning surface units shall feature a minimum of four (4) embedded corrosion resistant 1.50-inch zinc inserts with ½-inch diameter Stainless Steel fasteners, Fasteners must be covered with a structural water tight cap. Fasteners must be located BETWEEN the truncated domes (in the field) for maximum protection of the fastener integrity. Fasteners are NOT to be located in the truncated dome.

1. The field area shall consist of a non-slip textured surface with a minimum static coefficient of friction of 0.80, wet and dry.
2. At a minimum, tactile warning surface product thickness shall measure 3/8" (nominal) exclusive of the perimeter 5/8" thick by 1" wide flange structure. The body if the TWS Unit must consist of a SOLID body for maximum strength and to eliminate the possibility of air entrapment and cracking. "Hollow back," "honeycomb," or "waffle tiles" are not acceptable for use on this Project.

G. Cleaning materials used on site shall have code acceptable low VOC solvent content and low flammability.

H. The Specifications of the concrete, sealants and related materials shall be in accordance with the Contract Documents and the guidelines set by their respective manufacturers.

PART 3 - EXECUTION

3.1 INSPECTION OF SURFACES

A. Carefully inspect tactile supporting devices for conditions affecting application and performance of the work of this Section. Report defects in writing to Engineer. Do not proceed with tactile tile installation work until unsatisfactory conditions have been corrected.

B. Beginning work shall constitute acceptance of its conditions and any defects in tactile tile installation work resulting from such accepted application shall be corrected without further expense to the Authority.

3.2 PREPARATION

A. Coordinate tile installation, working with prior and subsequent work of other trades.

B. During all concrete pouring and tactile warning surface product installation procedures, ensure adequate safety guidelines are in place and that they are in accordance with the applicable industry and government standards.

C. The physical characteristics of the concrete shall be consistent with the Contract Specifications while maintaining a slump range of 4 - 7 to permit solid placement of the composite WET SET "*Replaceable*" tactile warning surface unit. An overly wet mix will cause the composite WET SET "*Replaceable*" tactile warning surface unit to float. Under these conditions suitable weights such as 2 concrete blocks or sandbags (25 pounds) shall be placed on each tactile warning surface unit.

D. The concrete shall be poured and finished, true and smooth to the required dimensions and slope prior to tactile warning surface unit placement.

3.3 INSTALLATION (PLATFORMS)

A. Install tile in accordance with manufacturer's recommendations and as indicated on the Drawings and as shown on approved shop drawings. Composite wet set replaceable tactile warning surface units shall be installed at the precast concrete platform panel precast shop at the time of casting.

1. All composite wet set replaceable tactile warning surface units shall be cast integrally with precast concrete platform panel flush with the finished surface of the platform panel under the supervision of a manufacturer-approved installer with documented experience in work similar to that of this Section.
2. All anchorages of composite wet set replaceable tactile warning surface units shall be fully embedded into precast concrete.
3. Composite wet set replaceable tactile warning surface units shall be suspended as part of the casting process to ensure that full bond of anchorages occurs. Composite wet set replaceable tactile warning surface units shall not be "pressed" into wet concrete.

B. Hold Point - The tiles shall be dry-fit and approved by the Engineer, prior to installation to ensure proper installation.

C. Minimize trimming by using whole tiles to the greatest extent possible. Any domes cut in trimming shall be beveled and polished.

D. At the platform radius, tiles shall be installed with the platform edge tangent to the radius with the ends trimmed to provide a joint tangent to the curve and square to adjoining tiles. Domes cut in the trimming shall be beveled and polished to match the finish of the tile.

E. The Installer shall leave a 1/8" nominal gap between successive Tactile Warning Surface Units. As part of the concrete finishing operation, the Installer shall apply ¼" edge treatment around the perimeter of the Tactile Warning Surface Units to facilitate future replacement of the Tactile Warning Surface Unit. A Urethane Sealant such as Sikaflex la or BASF Sonneborn NP1 shall be applied to the edge treatment for a watertight Tactile Warning Surface Unit installation.

F. When multiple tactile warning surface units regardless of size are used, the truncated domes shall be aligned between the tactile warning surface units and throughout the entire tactile warning surface installation.

G. Tactile warning surface unit shall flush to the adjacent concrete surface or as the Drawings indicate to permit proper water drainage and eliminate tripping hazards between adjacent finishes.

H. Apply sealant only at expansion joints in accordance with Section 07920 - JOINT SEALANTS.

I. Fasteners, as required by the platform conditions, shall be used to fully fasten the tile to the platform to provide complete contact between the tile and the platform.

3.4 INSTALLATION (CURB RAMPS)

A. Contractor will not be allowed to install Tactile Warning Surface Product until all submittals have been reviewed and approved by the Engineer.

B. Tactile warning surface product shall be installed per manufacturer's instructions.

C. To the maximum extent possible, the tactile warning surface units shall be oriented such that the rows of in-line truncated domes are parallel with the direction of the ramp. When multiple tactile warning surface units regardless of size are used, the truncated domes shall be aligned between the tactile warning surface units and throughout the entire tactile warning surface installation.

D. In accordance with the Revised Draft Guidelines for Accessible Public Rights of Way (11/23/05) Sections R221, R303.3.4, R304.2, tactile warning surface product shall be located so that the edge nearest the curb line is 6" minimum and 8" maximum from the curb line, This allows wheelchair users to gain momentum before traveling over the truncated domes and it provides visually impaired pedestrians additional time to react to the tactile warning surface or advanced warning before they reach the street.

E. The tactile warning surface units shall be tamped or vibrated into the fresh concrete to ensure that there are no voids or air pockets, and the field level of the tactile warning surface unit is flush to the adjacent concrete surface or as the Drawings indicate to permit proper water drainage and eliminate tripping hazards between adjacent finishes.

3.5 CLEANING AND PROTECTION

A. During construction and prior to opening the platform edge for public use, cover all tactile surfaces with an appropriate covering material, temporarily secured in place, to protect it from damage from construction activity. Remove covering when protection is no longer needed and dispose of it off-site in a manner conforming to all appropriate laws and regulations.

B. Protect tactile warning surface unit against damage during construction period to comply with tactile warning surface unit manufacturer's Specifications.

C. During and after the tactile warning surface unit installation and the concrete curing stage, it is imperative that there are no walking, leaning or external forces placed on the tactile warning surface unit to rock the tactile warning surface unit, causing a void between the underside of the tactile warning surface unit and the concrete substrate.

D. Prohibit construction vehicle traffic from riding on newly tiled surfaces. Do not place or store construction equipment or tools directly on tiled surfaces.

E. Provide snow removal as required using equipment that will not damage tile.

F. If requested by the Project Manager, clean tactile warning surface units not more than four (4) days prior to date scheduled for inspection intended to establish date of substantial completion in each area of project. Clean tactile warning surface unit by method specified by tactile warning surface manufacturer.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. No separate measurement will be made for modular tactile surfaces along the station platforms, but all costs in connection therefore shall be included in the Contract Lump Sum price for Item No. 0613.019 – Access Platform.

B. No separate measurement will be made for modular tactile surfaces to be placed within wheelchair ramps, but all costs in connection therefore shall be included in the Contract Unit price for Item No. 0263.150 – Concrete Sidewalks.

4.2 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0263.150	CONCRETE SIDEWALKS	SY
0613.019	ACCESS PLATFORM	LS

END OF SECTION

SECTION 09900

PAINTING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies the following items.

1. Field painting of exposed interior items and surfaces.
2. Field painting of exposed exterior items and surfaces.
3. Surface preparation for painting.
4. Painting of galvanized items
5. Surface preparation/cleaning and painting of existing steel superstructures at Sudbury River Bridge (MP 20.48) and Mill Pond Bridge (MP 40.01).
6. Field painting of steel superstructure at Assabet River Bridge (MP 21.76).
7. Implementation of worker protection programs, environmental protection, containment of the work and waste disposal in accordance with Section 02090 – Lead-Based Paint Abatement.

B. New coating systems for bridges included in this project shall be a three coat, non-lead (Pb), non-chromate, low VOC (450 grams/liter, max) system as approved by the Northeast Protective Coating Committee (NEPCOAT) in conformance with Massachusetts DEP Air Pollution Control Regulations 310 CMR 7.25-7.60 sub-part 11b Architectural & Industrial Maintenance Coatings Emission Standards TABLE 310 CMR 7.25(11) VOC Emission Limitations for Architectural or Industrial Maintenance Coatings. The contractor shall note that the bridge superstructures final coat color may be different at each bridge site.

C. Prior to welding, cutting, drilling, or burning away metal with lead-containing material, the Contractor shall remove the lead-containing material to a point at least 3 inches from the area where the welding, cutting or burning is to be performed or the Contractor shall supply air-line respirators to the respective workers (reference 29 CFR 1926.354).

D. The Contractor shall provide the Engineer safe access and support to all parts of the structure(s) for interim and final inspection of the bridge during cleaning and painting operations. This support shall include the necessary traffic controls, scaffolding, fall protection, and lighting. The traffic controls shall be paid for under their respective items and the scaffolding and lighting shall be incidental to this item.

E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 02577 - PAVEMENT MARKING: Traffic-marking paint.
2. Section 05041 – HOT DIPPED GALVANIZING: Shop painting galvanized structural steel.
3. Section 05100 - STRUCTURAL STEEL: Shop priming structural steel.
4. Section 05500 - MISCELLANEOUS METAL: Shop priming ferrous metal.
5. Section 08111 - STEEL DOORS AND FRAMES: Factory priming steel doors and frames.

1.2 DEFINITIONS AND EXTENT

A. General: Standard coating terms defined in ASTM D 16 apply to this Section.

1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
2. Eggshell refers to low-sheen finish with a gloss range between 20 and 35 when measured at a 60-degree meter.
3. Semi-gloss refers to medium-sheen finish with a gloss range between 35 and 70 when measured at a 60-degree meter.
4. Full gloss refers to high-sheen finish with a gloss range more than 70 when measured at a 60-degree meter.

B. This Section includes surface preparation and field painting of exposed exterior and interior items and surfaces.

1. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.

C. Paint exposed surfaces, except where these Specifications indicate that the surface or material is not to be painted or is to remain natural. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces. If a color of finish is not indicated, Engineer will select from standard colors and finishes available.

1. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron supports, and surfaces of mechanical and electrical equipment that do not have a factory-applied final finish.

D. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.

1. Prefinished items include, but are not limited to the following factory-finished components:
   a. Architectural woodwork.
   b. Acoustical wall panels.
   c. Metal toilet enclosures.
   d. Metal lockers.
   e. Kitchen appliances.
   f. Elevator entrance doors and frames.
   g. Elevator equipment.
   h. Finished mechanical and electrical equipment.
   i. Light fixtures.

2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
   a. Foundation spaces.
   b. Furred areas.
   c. Ceiling plenums.
   d. Utility tunnels.
   e. Pipe spaces.
   f. Duct shafts.
   g. Elevator shafts.

3. Finished metal surfaces include the following:
   a. Anodized aluminum.
   b. Stainless steel.

c. Chromium plate.
d. Copper and copper alloys.
e. Bronze and brass.

4. Operating parts include moving parts of operating equipment and the following:
   a. Valve and damper operators.
   b. Linkages.
   c. Sensing devices.
   d. Motor and fan shafts.

5. Labels: Do not paint over UL, FMG, or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

1.3 SUBMITTALS

A. Product Data: For each paint system indicated, include block fillers and primers.

1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.

B. Samples for Verification: For each color and material to be applied, with texture to simulate actual conditions, on representative Samples of the actual substrate.

1. Provide stepped Samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
2. Provide a list of materials and applications for each coat of each Sample. Label each Sample for location and application.
3. Submit two eight inch by 12 inch Samples for each type of finish coating for Engineer's review of color and texture only.

C. Qualification Data: For Applicator.

1.4 QUALITY ASSURANCE

A. Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

B. Source Limitations: Obtain block fillers and primers for each coating system from the same manufacturer as the finish coats.

C. Mockups: Provide a full-coat benchmark finish sample for each type of coating and substrate required. Comply with procedures specified in Painting and Decorating Contractors of America PDCA P5. Duplicate finish of approved sample Submittals.

1. Engineer will select one room or surface to represent surfaces and conditions for application of each type of coating and substrate.

a. Wall Surfaces: Provide samples on at least 100 sq. ft.
b. Small Areas and Items: Engineer will designate items or areas required.

2. Apply benchmark samples, according to requirements for the completed Work, after permanent lighting and other environmental services have been activated. Provide required sheen, color, and texture on each surface.
   a. After finishes are accepted, Engineer will use the room or surface to evaluate coating systems of a similar nature.

3. Final approval of colors will be from benchmark samples.

D. Requirements of regulatory agencies. Provide and apply materials complying with environmental requirements of authority having jurisdiction including all current and applicable VOC level regulations.

E. All paint shall be from the same manufacturing plant and shall have a minimum of eleven months remaining on its shelf life when received at the job.

F. Tolerances

1. Thickness
   a. Apply paint of specified Dry Film Thickness (DFT), which thickness shall be absolute minimum coverage at any point of measurement. Where DFT cannot be practically measured, apply each coat at the manufacturer's DFT equivalent published spread rate, with proper allowance for waste for method of application.
   b. Certain items indicated will be prime painted under other Sections; however, attain total DFT specified a minimum.

G. Certificates

1. Provide certificates listing materials used in painting coating systems and certify compliance with standards designated.

2. Provide certificates stating that materials provided comply with requirements of Article 1.4.D.

H. Reference Standards the Contractor shall comply with all applicable regulations even if the regulation is not specifically referenced herein. If a State or local regulation is more restrictive than the requirements of this Specification, follow the more restrictive requirements.

1. State Regulations
   a. 310 CMR 7.00 Air Pollution Control
   b. 310 CMR 30.00 Hazardous Waste Regulations
   c. 310 CMR 40.00 Massachusetts Contingency Plan
   d. 310 CMR 19.00 Solid Waste Management Regulations
   e. 314 CMR 1.00 - 30.00 Water Pollution Control Regulations

2. Federal Regulations
   a. 310 CMR 7.00 Air Pollution Control
   b. 29 CFR 1910, Occupational Safety and Health Regulations for General
   c. 29 CFR 1926, Occupational Safety and Health Regulations for the Construction Industry
   d. 29 CFR 1926.62, Lead
   e. 40 CFR 50, National Primary and Secondary Ambient Air Quality Standards
   f. 40 CFR 58, Ambient Air Quality Surveillance

g. 40 CFR 60, App. A, Method 22, Visual Determination of Fugitive Emissions from Material Sources and Smoke Emissions from Fires
h. 40 CFR 265, Subpart D, Contingency Plan and Emergency Procedures
i. The U.S. Environmental Protection Agency (EPA)
j. SW 846 Test Methods for Evaluating Solid Waste - Physical/Chemical Methods
k. Method 1311, Toxicity Characteristic Leaching Procedure (TCLP)

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SP 1	Solvent Cleaning
SP 10	Near White Blast Cleaning
PA 2	Measurement of Dry Paint Thickness with Magnetic Gauges
Vis 1	Visual Standard for Abrasive Blast Cleaned Steel
AB-2	Abrasive Specification No. 2, Specification for Cleanliness of Recycled Ferrous Metallic Abrasives.
AB-3	Abrasive Specification No. 3, Newly Manufactured or Re-Manufactured Steel Abrasives.
Guide 3	A Guide to Safety in Paint Application
Guide 6	Guide for Containing Debris Generated During Paint Removal Operations

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D 4285	Detecting Oil or Water in Compressed Air
D 4414	Standard Practice for Measurement of Wet Film Thickness by V Notch Gages, Procedure *A*
D 4417	Measurement of Surface Profile, Method C
E 337	Test Method for "Measuring Humidity with a Psychrometer" (The Measurement of Wet and Dry Bulb Temperatures)

Inspection Equipment

Prior to the start of any cleaning or painting operations, the contractor shall furnish the following inspection equipment to the Engineer:

4 Wet Film Thickness Gauges (notch type, as specified in ASTM D 4414, procedure *A*)
1 Dry Film Thickness Gauge - type two, with memory and download capabilities (Posi-Tector 6000, Elecometer 345, Quanix or approved equal)
1 Sling Psychrometer with two replacement thermometers, (Bacharach, Taylor, Ertco or approved equal)

1 National Weather Bureau psychrometric tables
1 Magnetic Surface Temperature Thermometer (calibrated/certified, range 0° – 150° F)
1 Spring loaded micrometer with coarse and x-coarse profile replica tape (a quantity of tape sufficient to complete inspection)
1 Surface Profile Comparator, comprised of, 10x flash light magnifier and 1 grit/slag disc or coupon, Keane-Tator, Elcometer, Clemtex or approved equal.
1 Quantitative soluble contaminates test kit, (Bresle, Chlor*Test, or approved equal)
1 Inspection mirror, telescopic with a mirror surface of approximately eight square inches
1 9 volt lantern
1 High/Low Recording Thermometer (for paint storage area)
1 Incline Manometer
1 Velometer
1 Light Meter
1 SSPC VIS 1 Standards

I. All equipment shall be in usable condition and complete with all necessary components and instructions for the proper calibration and function. Equipment found to be incomplete or unable to be field calibrated should be immediately replaced. All equipment shall remain the property of the Contractor upon completion of the project.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:

1. Product name or title of material.
2. Product description (generic classification or binder type).
3. Manufacturer's stock number and date of manufacture.
4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.
8. VOC content.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F and a maximum ambient temperature of 95 deg F. Maintain storage containers in a clean condition, free of foreign materials and residue.

1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily.

1.6 PROJECT CONDITIONS

A. Apply waterborne paints only when temperatures of surfaces to be painted and surrounding air are between 50 and 90 deg F.

B. Apply solvent-thinned paints only when temperatures of surfaces to be painted and surrounding air are between 45 and 95 deg F.

C. Do not apply paint in snow, rain, fog, or mist; or when relative humidity exceeds 85 percent; or at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

D. All shop-applied special coatings shall be done under environmental conditions strictly in accordance with the coating manufacturer's recommendations for ambient temperature, humidity, ventilation, surface preparation and other conditions.

E. Application of organic zinc, epoxy, and urethane systems shall not be done when the relative humidity is above 85% or when the surface temperature of the steel is less than 5°F above the Dew Point. Paint shall not be applied when the surface temperature is below 40°F or when the surface temperature is above 125°F.

F. Application of moisture cure urethane systems shall not be done when the relative humidity is above 95% or when the surface temperature of the steel is less than 5°F above the Dew Point and rising. Paint shall not be applied when the surface temperature is below 40°F or when the surface temperature is above 125°F.

G. Paint shall not be applied when, in the Engineer's judgment, conditions are or will become unsatisfactory for application and proper cure. All changes as to the application parameters other than specified must be the manufacturers and presented in writing and approved by the Engineer.

H. Measurement of the ambient conditions shall be done in accordance with ASTM, E 337 Test Method for "Measuring Humidity with a Psychrometer" (the Measurement of Wet and Dry bulb Temperatures).

PART 2 - PRODUCTS

2.1 PAINT MATERIALS, GENERAL

A. Material Compatibility: Provide block fillers, primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.

1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.

C. All structural steel coating systems shall be modified at steel connections as necessary to meet or exceed slip coefficient requirements or AISC for fully coated connections.

D. All paint for steel bridges shall be a three (3) coat system as approved by NEPCOAT - Qualified Products –List B "for Protective Coating for New and 100% Bare Existing Steel for Bridges (for sample materials - Article 2.03 Materials, E). The colors of the prime, intermediate and finish coats shall have a definite color contrast between them and be subject to the approval of the Engineer. Minimum and maximum dry film thickness shall be in accordance with the latest manufacturer's data sheet for each product applied.

E. Paints shall meet Acceptance Criteria for AASHTO R31 Testing – List A, B, "for Protective Coating for New and 100% Bare Existing Steel for Bridges

F. Pre-Approved Paint Systems

1. For Exterior Ferrous Metal,:
(Surface Preparation: Per manufacturers' specifications

One Coat 1. Carboline-Carbozinc 859 Organic Zinc Rich Primer at 3.0 – 10.0mils DFT
2. Ameron-Amercoat 68HS Zinc Rich Primer at 3.0 mils DFT

3. PPG Industries Aquapon 97-670 Zinc Rich Primer at 3.0 – 4.0 mils DFT

One Coat 1. Carboline- Carboguard 888 Epoxy Polyamide at 3.0- 10.0 mils DFT
2. Ameron –Amercoat 399 Fast Drying Epoxy at 4.0-8.0 mils DFT
3. PPG Industries Pitt- Guard97-946 at 4.0 to 7.0 mils DFT

One Coat 1. Carboline- Carbothane 133 HBAliphatic Polyurethane at 3.0-7.0 mils DFT
2. Ameron - Amercoat 450H Topcoat at 2.0 to 3.0 mils DFT
3. PPG Industries–Pitthane 95-8800 HB Urethane Enamel at 2.0 - 5.0 mils DFT

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for paint application.

1. Proceed with paint application only after unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
2. Start of painting will be construed as Applicator's acceptance of surfaces and conditions within a particular area.

B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

1. Notify Engineer about anticipated problems when using the materials specified over substrates primed by others.

3.2 PREPARATION

A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of size or weight of the item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

B. Cleaning: Before applying paint or other surface treatments, clean substrates of substances that could impair bond of the various coatings. Remove oil and grease before cleaning.

1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.

1. Provide barrier coats or tie-coats over incompatible primers or remove and reprime.

2. Cementitious Materials: Prepare concrete, concrete unit masonry, cement plaster, and mineral-fiber-reinforced cement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation to remove.
   a. Use abrasive blast-cleaning methods if recommended by paint manufacturer.
   b. Determine pH of surfaces using pH indicating papers and distilled water and perform moisture vapor transmission testing for concrete floors in accordance with ASTM F 1869 and moisture tests on concrete walls in accordance with ASTM D 4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method. For masonry walls, use a moisture meter approved by the coating manufacturer. Follow the selected and approved coating manufacturers recommendations for acceptable pH values, moisture vapor transmission values (in lbs. of moisture per 24 hours per 1,000 SF), and moisture meter values (for masonry). If these values are not acceptable, do not paint surfaces until moisture levels are acceptable or additional surface preparation has been performed and the pH values measured are acceptable
   c. Clean concrete floors to be painted with shot blast equipment.

3. Wood: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.

   a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or other recommended knot sealer before applying primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dried.
   b. Prime, stain, or seal wood to be painted immediately on delivery. Prime edges, ends, faces, undersides, and back sides of wood, including cabinets, counters, cases, and paneling.
   c. If transparent finish is required, backprime with spar varnish.
   d. Backprime paneling on interior partitions where masonry, plaster, or other wet wall construction occurs on back side.
   e. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately on delivery.

4. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with The Society for Protective Coating's (SSPC) recommendations.
   a. Blast steel surfaces clean as recommended by paint system manufacturer and according to SSPC-SP 6/NACE No. 3, SSPC-SP 10/NACE No. 2, or SSPC-SP 12 Water Jetting at 45,000 psi as specified in the Paint Schedule in this Section.
   b. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
   c. Treat existing painted surfaces with surface preparation methods recommended by coating manufacturer and in accordance with the coating schedule.

5. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods. Use Oakite Cleaner LTS or equal for pretreatment of any non-primed galvanized metal before finish painting.

D. Surface preparation for existing steel bridges: Pressure washing is required for all surfaces of the structure that are to be painted, unless otherwise directed by the Engineer.

1. Prior to pressure washing, the Contractor shall remove all accumulated debris from abutments, pier caps, girder flanges and other areas of collection. Debris may include but are not limited to, sand, gravel, ballast, deteriorated steel, bituminous materials and bird droppings. The method of removal shall allow for the collection and proper disposal of the debris in accordance with the Section 02090 Lead-Based Paint Abatement portion of these specifications.

2. The minimum requirements for the containment of pressure washing are identified in the Section 02090 Lead-Based Paint Abatement portion of these specifications. All water used shall be collected, filtered, tested and disposed of in accordance with the Section 02090 Lead-Based Paint Abatement portion of these specifications. All water used for pressure washing operations shall be potable and supplied by the Contractor.

3. Pressure washing shall not be performed more than seven days prior to the start of abrasive blasting. Prior to the start of abrasive blasting, the Engineer will inspect the cleaned surface to insure that it is acceptable. The Contractor shall re-clean unacceptable surfaces, in the specified manner.

4. Portable pressure washing equipment shall be operated at a minimum of 3000 psi; a water temperature of 200° F and a minimum consumption of six gallons per minute shall be used to clean all surfaces to be painted of visible and non-visible contaminants. Pressure washers shall be equipped with gauges to ascertain operating pressure and temperature. The use of an oscillating or rotary type nozzle is recommended for all washing.

5. Each pressure-washing unit shall have a cleaning compound supply tank with the ability to control the amount of solution being supplied to the feed water. Cleaning solutions shall be used in strict accordance with the manufacturer's written recommendations. The cleaner shall also be, non-flammable and non-reactive and shall be compatible with paint system be applied.

6. All dirt, oil, grease, tar, road salt, bird dropping residue, chalky paint and other dissolvable debris and contaminates shall be removed by pressure washing. The surface should first be wetted to allow the cleaning compound to loosen foreign matter, which is later removed by a cleaning pass. The time interval between wetting and cleaning should be regulated according to the degree of contamination. The speed of the pass over an area shall also be regulated by the degree of contamination and rate of removal. The operator should hold the face of the nozzle at a distance and angle to the surface that will provide the greatest cleaning rate and desired cleanliness.

7. Excessive deposits of cleaning liquids remaining on surfaces that will not drain shall be flushed off with clean, fresh water without detergent. In as much as a certain amount of liquid will remain on horizontal surfaces after cleaning, the cleaning process shall be followed through from top to bottom very systematically. The last pass on any surface shall be made with clean fresh water without detergent to remove surplus solution.

8. The Contractor shall be solely responsible for damages arising from pressure washing operations. Expansion joints or open areas that will allow debris or water to pass shall be covered or sealed to protect vehicle and/or pedestrian traffic.

9. Under no circumstances will abrasive blast cleaning or painting be started over cleaned surfaces until the surface is free of standing water and dry to the touch, and then only after the approval of the Engineer.

10. All equipment, materials and vehicles brought to the site by the Contractor shall be clean and free of debris. A visual assessment of cleanliness shall be made by the Engineer prior to locating equipment at the contract location(s).

11. The minimum requirements for containment of dry abrasive blasting operations are identified in the Section 02090 Lead-Based Paint Abatement portion of these specifications.

12. The Contractor shall immediately report to the Engineer any cracks, section loss or other potential problems found during surface preparation. Sliding surfaces of bearings and neoprene pads shall be protected from damage during cleaning and painting operations.

13. All surfaces to be painted shall be abrasive blast cleaned to meet the requirements of SSPC SP-10 "Near White Metal Blast" using recyclable steel abrasives. A near-white blast cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter. At least 95% of each unit area measuring nine square inches shall have the appearance of a white metal blast, and the remainder is limited to slight discolorations.

14. A standard of cleaning for SSPC-SP-10 "Near White Blast Cleaning" shall be established prior to full blast cleaning operations. The surface for the standard (or control) should be a flat portion of the surface actually to be cleaned and shall be located by the Engineer. To establish this standard, SSPC-VIS 1 shall be used. An area not less than four square feet shall be blast cleaned to meet the requirements of a near white blast, and approved by the Engineer. After approval and at the option of the Engineer, the cleaned area will be sealed with a clear protective paint to preserve its appearance. Upon completion of the surface preparation and application of the primer, the standard will be abrasive blast cleaned and coated in accordance with these specifications.

15. The specified height of the surface profile is 1 to 3 mils and shall be uniform. Verification of the profile height will be performed with both coarse (.8 to 2.0 mil) and extra coarse (1.5 to 3.0mil) surface profile replica tape, in accordance with ASTM D 4417 Method C. The tape is a record to be filed with the project inspection records. The use of coarse tape is not required if the profile is found to be consistently between 1.0 to 3.0 mils by the Engineer.

16. The profile shall be measured three times in random locations every 250ft^2 of prepared surface and approved by the Engineer.

17. Steel grit used for abrasive blasting shall be in accordance with SSPC-AB 2 and SSPC-AB 3. The selected abrasive shall be capable of producing a profile within the range specified. The profile shall be of sufficient angularity as to be acceptable by the paint manufacturer for the application of primer. The Engineer with the use of a surface profile comparator will randomly inspect angularity of the profile.

18. All abrasives will be maintained clean, dry and uncontaminated. The abrasive shall be tested daily for grease, oil or non-abrasive residue with a "vial test" using the following method:
    a. A sealable jar is filled with distilled water, a sample of recycled abrasive taken from the storage hopper or pressure vessel and is then added to the jar. The vial is shaken for one minute and allowed to set for five minutes. The vial is observed. If any oil or grease is floating on the top of the water, then the abrasive will be considered contaminated. A cloudy condition will be evidence of non-abrasive residue and considered contaminated.

b. No contaminated steel grit will be used for surface preparation. Abrasive found to be contaminated should be recycled or disposed of in accordance with the Section 02090 Lead-Based Paint Abatement portion of these specifications.

19. Upon completion of blast cleaning and prior to inspection, the Contractor shall vacuum or blow down under full ventilation and containment all surfaces to be inspected, providing areas for testing and to aid visual inspection of the substrate.

20. Paints and solvents are hazardous due to their flammability and potential toxicity. Proper safety precautions shall be observed to protect against these recognized hazards. Proper ventilation and handling shall be employed during mixing and application to insure that vapor concentrations do not exceed the published Permissible Exposure Limits (P.E.L.) and the Lower Explosion Limit (L.E.L.). Safety practices should include but are not limited to the provisions of SSPC -PA Guide 3 "A Guide To Safety in Paint Application".

21. Prior to the application of any coating, all dust and debris shall be removed by vacuuming or blowing down under full ventilation and containment. Painting of the approved area will not be allowed until the area has been properly ventilated to remove all airborne dust.

22. Surface preparation and subsequent paint application shall be so programmed that dust and other contaminants from the cleaning process will not fall on surfaces about to receive paint, or on wet, newly painted surfaces.

23. Surfaces approved will not be allowed to stand uncoated longer than eight hours unless some form of protective environmental procedure is utilized, e.g., dehumidification. If substrate is found to have degraded, it will be recleaned in the specified method at the Contractors expense.

24. All surface preparation will be reviewed and approved by the Engineer prior to painting operations. The Contractor shall provide safe access to the entire structure to allow the Engineer to conduct inspection and testing activities, e.g., dry film thickness, surface profile, atmospheric conditions, etc.

E. Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.

1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
3. Use only thinners approved by paint manufacturer and only within recommended limits.

F. Tinting: Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.

1. Paint colors, surface treatments, and finishes are indicated in the paint schedules.

2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
3. Provide finish coats that are compatible with primers used.
4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, grilles, convector covers, covers for finned-tube radiation, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
6. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.
7. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
8. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
9. Sand lightly between each succeeding enamel or varnish coat.

B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
2. Omit primer over metal surfaces that have been shop primed and touchup painted.
3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.

C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.

D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.

E. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and occupied spaces.

F. Mechanical items to be painted include, but are not limited to, the following:

1. Uninsulated metal piping.
2. Uninsulated plastic piping.
3. Pipe hangers and supports.
4. Tanks that do not have factory-applied final finishes.
5. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
6. Duct, equipment, and pipe insulation having "all-service jacket" or other paintable jacket material.
7. Mechanical equipment that is indicated to have a factory-primed finish for field painting.

G. Electrical items to be painted include, but are not limited to, the following:

1. Switchgear.
2. Panelboards.
3. Electrical equipment that is indicated to have a factory-primed finish for field painting.

H. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.

I. Prime Coats: Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.

J. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

K. Transparent (Clear) Finishes: Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, nail holes, or other surface imperfections.

1. Provide satin finish for final coats.

L. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.4 CLEANING

A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from Project site.

1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping without scratching or damaging adjacent finished surfaces.

B. Clean-up shall be in accordance with the applicable provisions of Section 02090, Lead-Based Paint Abatement.

3.5 ENVIRONMENTAL MONITORING AND PROTECTION OF AMBIENT AIR, SOIL, AND WATER

A. The Contractor shall monitor and protect ambient air, soil, and water in accordance with Section 02090, Lead-Based-Paint Abatement.

3.6 WORKER HEALTH AND SAFETY

A. Worker health and safety shall conform to the relevant provisions of Section 02090, Lead-Based Paint Abatement.

3.7 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage from painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Engineer.

B. Provide "Wet Paint" signs to protect newly painted finishes. After completing painting operations, remove temporary protective wrappings provided by others to protect their work.

1. After work of other trades is complete, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in Painting and Decorating Contractors of America PDCA P1.

3.8 PAINT SCHEDULE

A. Schedule: Provide products and number of coats specified. Use of manufacturer's proprietary product names to designate colors, materials, generic class, standard of quality and performance criteria and is not intended to imply that products named are required to be used to the exclusion of equivalent performing products of other manufacturers.

B. Exterior Paint Schedule:

1. Exterior Masonry and Concrete to be Painted (where indicated):

   One Coat
   1. Tnemec Series 156 Enviro-Crete at 6.0 to 10 mils DFT
   2. Liquid Plastics Acrylic at 8.0 to 10.0 mils DFT
   3. Dupont Tufcryl at 8.0 to 10.0 mils DFT
   4. Amercoat Series 147 at 3.0 to 6.0 mils DFT

   One Coat
   1. Tnemec Series 156 Enviro-Crete at 8 to 10 mils DFT
   2. Liquid Plastics Acrylic at 8.0 to 10.0 mils DFT
   3. Dupont Tufcryl at 8.0 to 10.0 mils DFT
   4. Amercoat Series 147 at 3.0 to 6.0 mils DFT

2. Exterior Masonry and Concrete to be stained (where indicated):

   One Coat 1. Chemprobe Prima-pel H20 100 to 125 sq/gal

   One Coat 1. Chemprobe Conformal Stain WB 100 to 110 sq/gal

3. Exterior Plaster, Glazed Brick, Previous Painted Masonry and Previous Painted Concrete (where indicated):

One Coat
1. Series 151-1051 Elasto-Grip at 2.0 to 3.0 mils DFT.
2. Liquid Plastics Water Borne Penetrating Primer at 3.0 mils DFT
3. Amercoat Series 220 at 3.0 to 6.0 mils DFT

Two Coats
1. Series 156 Enviro-Crete at 8 to 10 mils DFT
2. Liquid Plastics Decadex at 10.0-12.0 mils DFT
3. Amercoat Series 220 at 3.0 to 6.0 mils DFT

4. Exterior Ferrous Metal, Urethane System: (Surface Preparation: SSPC-SP6)

One Coat
1. Tnemec Series 90-1K97 at 3 mils DFT; shop applied under other Sections; use for touch up
2. Ameron Series 68 at 3 mils DFT; shop applied under other Sections; use for touch up
3. Dupont Urethane Ganicin Zinc Rich Primer 80%zinc load at 3.0 mils DFT

One Coat
1. Tnemec Series N69 Hi-Build Epoxoline II at 3.0 mils DFT
2. Ameron Amerlock 400 Hi-Build Epoxy at 3.0 to 5.0 mils DFT.
3. Dupont 25P High Solids Epoxy at 4.0 –6.0 mils DFT

One Coat
1. Tnemec Series V73 Endura-Shield at 3.0 mils DFT
2. Ameron Amerlock 450H Polyurethane Topcoat at 3.0 mils DFT
3. Dupont High Solids Imron Urethane at 4.0 mils DFT

5. Exterior Ferrous Metal, Fluoropolymer System: (Surface Preparation: SSPC-SP6)

One Coat
1. Tnemec Series 90-1K97 at 3.0 mils DFT; use for touch up
2. Dupont Ganicin Urethane Zinc Rich at 3.0 mils DFT

One Coat
1. Tnemec Series V73 Endura-Shield at 3.0 mils DFT
2. DuPont Imron HS at 3.0 mils DFT

One Coat
1. Tnemec Series 1070 Fluoronar at 2.0 mils DFT with [1078 metallic] [1071 satin] [1072 semi-gloss] finish
2. Dupont Fluoropolymer at 3.0 mils DFT

6. Exterior Ferrous Metal, Engineered Siloxane/ Polyester Urethane System: (Surface Preparation: SSPC-SP6)

One Coat
1. Tnemec 901K97 at 3.0 mils DFT
4. Ameron Series 68HS at 3.0 mils DFT
5. Dupont Urethane Zinc Rich Primer 80% zinc load at 3.0 mils DFT

One Coat
1. Tnemec V27 Typoxy at 3.0- 4.0 mils DFT
4. Ameron Amerlock 400 High Build Epoxy at 3.0 mils DFT
5. Dupont 25P High Solids Epoxy at 4.o mils DFT

One Coat
1. Tnemec 290/291 Endurashield at 2.0-3.0 mils DFT
4. Ameron PSX-700 Engineered Siloxane Topcoat at 5.0 mils DFT
5. Dupont Imron High Solids Polyester Urethane at 3.0 mils DFT

7. Exterior Non-Ferrous Metal (except aluminum): (Surface Preparation: Sand with 60 grit scotch brite pads followed by SSPC-SP1)

One Coat
1. Tnemec Series N69 Hi-Build Epoxoline II at 3.0 mils DFT.

2. Ameron 400 Amerlock at 4.0 to 5.0 mils DFT
3. Dupont 25P High Solids at 5.0 mils DFT

One Coat
1. Tnemec Series V73 Endurashield at 3.0 mils DFT
2. Ameron Amercoat 450H Polyurethane at 3.0 mils DFT
3. Dupont High Solids Imron at 4.0 mils DFT

8. Exterior Galvanized Metal (not shop-finished under Sections 05100 or 05500): (Surface Preparation: SSPC-SP7 Brush-off Blast)

One Coat
1. Tnemec Series V27 Typoxy at 3.0 mils DFT
2. Ameron Amerlock 400 Hi-Build Epoxy at43.0 mils DFT
3. Dupont 25P High Solids at 4.0 mils DFT

One Coat
1. Tnemec Series V73 Endura-Shield at 3.0 mils DFT
2. Ameron Amercoat 450H Polyurethane at 3.0 mils DFT
3. Dupont Imron 2.8 Urethane at 3.0 to 4.0 mils DFT

9. Exterior Aluminum (Where Required): (Surface Preparation: Pressure Wash with Oakite and sanding with Scotch Bright pads)

One Coat
1. Tnemec Series V27 Typoxy at 2.0 mils DFT
2. Ameron Amerlock 400 Hi-Build Epoxy at 2.0 to 3.0 mils DFT
3. Dupont 25P High solids at 4.0 mils DFT

One Coat
1. Tnemec Series V73 Endura-Shield at 2.0 mils DFT
2. Ameron Amercoat 450H polyurethane at 3.0 mils DFT
3. Dupont High Solids Imron 2.8 at 4.0 mils DFT

10. Concrete in Immersion: (Surface Preparation- SSPC-SP7 Brush Blast Clean)

One Coat
1. Tnemec 446 Permathane at 7.0 to 9.0 mils DFT
2. Ameron Amerlock 400 at 6.0-8.0 mils DFT
3. Dupont Moisture Cured Urethane at 10-12 mils DFT

One Coat
1. Tnemec 446 Permathane at 7.0 to .09 mils DFT
2. Ameron Amerlock 400 at 6.0 to 8.0 mils DFT
3. Dupont Moisture Cured Urethane at 10.0 to 12.0 mils DFT

11. Steel Piles in Immersion: (Surface Preparation- SSPC-SP10 Near White Metal Blast Clean)

One Coat
1. Tnemec Series 9097 or Series 90-1K97 at 3.0 mils DFT
2. Ameron Series 68 HS Zinc 3.0 mils DFT
3. Dupont Urethane Zinc Rich NSF Grade primer at 4.0 –5.0 mils DFT

Two Coats
1. Tnemec 446 Permathane at 7.0 to 9.0 mils DFT
2. Ameron Amerlock 400 with glass flake at 10.0-12.0 mils DFT
3. Dupont Moisture Cured Urethane at 10.0 DFT

12. Existing Exterior Painted Steel for Sandblasting and Finish: (Surface Preparation- SSPC-SP 10 Near White Metal Blast)

One Coat
1. Tnemec 90-97 or 901K97 at 3 to 3.5 mils DFT
2. Ameron Series 68 HS at 3.0 mils DFT
3. Dupont Ganicin 80% Zinc load Zinc Rich Primer at 3.0 to 3.5 mils DFT

One Coat
1. Tnemec V73 Endurashield at 3.0 to 4.0 mils DFT

2. Ameron Amerlock 400 at 4.0 DFT
3. Dupont Imron 2.8 at 4.0-5.0 mils DFT

One Coat
1. Tnemec 1070 Fluoronar at 2.5 to 3.5 mils DFT
2. Ameron PSX-700 Coating at 5.0 mils DFT
3. Dupont Fluoropolymer at 3.0 mils DFT

13. Existing Exterior Painted Steel for Overcoat Finish: (Surface Preparation : Water Blast 5000 psi/ SSPC-SP3 Power Tool Clean)

One Coat
1. Tnemec 394 Omnithane at 2.5 to 3.0 mils DFT
2. Ameron Amerlock 400 Hi-Build Epoxy at 3.0 to 4.0 mils DFT
3. Dupont 25P at 4.0 mils DFT

One Coat
1. Tnemec V27 Typoxy at 3.0 to 5.0 mils DFT
2. Ameron Amerlock 400 at 3.0 to 4.0 mils DFT
3. Dupont 25P at 4.0 mils DFT

One Coat
1. Tnemec V73 Endurashield at 3.0 to 5.0 mils DFT
2. Ameron Amercoat 450H at 3.0 mils DFT
3. Dupont 2.8 Imron at 4.0 to 6.0 mils DFT

C. Interior Paint Schedule for Standard Performance Coatings:

1. Interior Gypsum Wallboard and Plaster for Latex Eggshell Finish:

One Coat
1. Moore Ecospec Interior Latex Primer Sealer (231)
2. Duron Genesis Latex Primer
3. S-W Health Spec Latex Wall Primer
4. PPG Pure Performance Latex Primer

Two Coats
1. Moore Pristine Ecospec Interior Latex Eggshell (223)
2. Duron Genesis Latex Eggshell
3. S-W Health Spec Latex Eggshell
4. PPG Pure Performance Latex Eggshell

2. Interior Gypsum Wallboard and Plaster Ceilings for Latex Flat Finish:

One Coat
1. Moore Ecospec Interior Latex Primer Sealer (231)
2. Duron Genesis Latex Primer
3. S-W Health Spec Latex Wall Primer
4. PPG Pure Performance Latex Primer

Two Coats
1. Moore Pristine Ecospec Interior Latex Flat (219)
2. Duron Genesis Latex Flat
3. S-W Health Spec Latex Flat
4. PPG Pure Performance Latex Eggshell

3. Interior Gypsum Wallboard and Plaster for Latex Semi-Gloss Finish:

One Coat
1. Moore Ecospec Interior Latex Primer Sealer (231)
2. Duron Genesis Latex Primer
3. S-W Health Spec Latex Wall Primer
4. PPG Pure Performance Latex Primer

Two Coats
1. Moore Pristine Ecospec Interior Latex Semi-Gloss (224)
2. Duron Genesis Latex Semi-Gloss
3. S-W Health Spec Latex Semi-Gloss
4. PPG Pure Performance Latex Semi-Gloss

4. Interior Architectural Woodwork, Finish Carpentry, and Wood Doors for Latex Semi-Gloss Paint Finish (softwoods, paint grade hardwoods, MDO, and hardwood veneers):

One Coat
1. Moore Ecospec Interior Latex Primer Sealer (231)
2. Duron Genesis Latex Primer
3. S-W Health Spec Latex Primer
4. PPG Pure Performance Latex Primer

Two Coats
1. Moore Pristine Ecospec Interior Latex Semi-Gloss (224)
2. Duron Genesis Latex Semi-Gloss
3. S-W Health Spec Latex Semi-Gloss
4. PPG Pure Performance Latex Semi-Gloss

5. Interior Architectural Woodwork, Finish Carpentry and Millwork for Satin Transparent Finish (all hardwoods and hardwood veneers, except paint grade and factory-finished items):

Sand 120 grit sandpaper
Sand 220 grit sandpaper

One Coat Stain
1. Carver Tripp Waterbase Stain
2. Knute's Restoration EF Waterbase Stain
3. American Formulating & Manuf., SafeCoat Durostain

Two Coats
1. Bona Kemi USA, Bona Tech Mega Waterbase Polyurethane
2. Target Coatings, Oxford Hybrid Satin Varnish
3. American Formulating & Manuf., Polyureseal BP

Sand Between Urethane Coats 220 grit sandpaper

6. Interior Concrete Masonry Units for Latex Semi-Gloss Finish in Dry Areas:

One Coat
1. PPG Speedhide Int/Ext Latex Block Filler (28g/l VOC formulation.)

Two Coats
1. PPG Pure Performance Latex Semi-Gloss

D. Interior Paint Schedule for High Performance Coatings:

1. Interior Concrete Ceiling Surfaces for Acrylic - Semi-Gloss Finish in Dry Areas:

One Coat
1. Tnemec Series 151 Elasto-grip at 2.0 mils DFT
2. Ameron Amerlock Sealer at 1.0 mils DFT
3. Dupont High Solids Acrylic Primer 2.0 mils DFT

Two Coats
1. Tnemec 28/29 Tufcryl at 2.0 –3.0 mils DFT per coat min.
1. Ameron Amercoat 220 at 3.0 mils DFT
2. Dupont High Solids Acrylic at 3.0 mils DFT

2. Interior Concrete Block, Epoxy Coating:

(Surface Preparation: Cured, clean and dry, free of surface contaminants)

One Coat
1. Tnemec 130 Envirofil at 100 sq/ft/gal
2. Ameron Amercoat 147 at 100 sq/ft/gal
3. Dupont 25P at 100 sq/ft/gal

One Coat
1. Tnemec 280 Tneme- glaze at 6.0 8.0 mils DFT
2. Ameron Amercoat 351 6.0-8.0 mils DFT
3. Dupont 100% Solids Epoxy at 7.0 to 9.0 mils DFT

One Coat:
1. Tnemec 1080 Endurashield at 3.0 – 4.0 mils DFT
2. Ameron Amercoat 335 at 3.0 to 4.0 mils DFT
3. Dupont Imron WB Urethane at 3.0 to 4.0 mils DFT

3. Interior Concrete Walls Exposed to View, Urethane Coating:
(Surface Preparation: Cured , clean and dry, free of surface contaminants)

One Coat
1. Tnemec 201 Epoxoprime at 3.0- 4.0 mils DFT
2. Ameron Amerlock Sealer 1.0-1.5 mils DFT
3. Dupont Hi-Solids Colar primer at 3.0 –4.0 mils DFT

One Coat
1. Tnemec 280 Tneme-glaze at 6.0 to 8.0 mils DFT
2. Ameron Amercoat 351 Epoxy at 6.0 to 8.0 mils DFT
3. Dupont 100 % Solids Epoxy at 8.0-10.0 mils

One Coat
1. Tnemec 297 Enviroshield WB at 3.0 to 3.5 mils DFT
2. Ameron Amercoat 335 at 2.0 to 3.0 mils DFT
3. Dupont WB Urethane at 3.5 to 4.0 mils DFT

4. Interior Concrete Walls Exposed to View, Epoxy Coating for Non-Immersion Service:
(Surface preparation- Cured , clean ,dry and free of contaminants)

One Coat
1. Tnemec 201 Epoxoprime at 2.0-3 mils DFT
2. Ameron Amerlock Sealer at 1.0-1.5 mils DFT
3. Dupont 25P Epoxy at 6.0 –8.0 mils DFT

One Coat
1. Tnemec 280 Tneme-glaze at 6.0 to 8.0 mils DFT
2. Ameron Amercoat 351 6.0 to8.0 mils DFT
3. Dupont 100% Solids Epoxy at 8.0 –10.mils DFT

One Coat
1. Tnemec 1080 Endurashield 2.0 to 3 mils DFT
2. Ameron Amercoat 335 at 2.0 to 3.0 mils DFT
3. Dupont WB Urethane at 3.0 to 4.0 mils DFT

5. Concrete Ceiling Coating –New or Previously Painted or Acoustical Plaster
(Surface Preparation- Cured Clean and Dry)

One Coat
1. Tnemec 151 Elasto-grip at 2.0 mils DFT

One Coat
1. Tnemec 158 Biolastic at 8.0 mils DFT

One Coat
1. Tnemec 158 Biolastic at 8.0 mils DFT

6. Interior Metals, Epoxy (Not specified to receive other coating systems/not shop finished):

One Coat 1. Approved primer, in shop under other Sections (where specified). If not shop primed, provide primer recommended by finish coating manufacturer

One Coat
1. Tnemec V27 Typoxy at 2.0 mils DFT
2. Ameron Amerlock 400 at 2.0 to 4.0 mils DFT
3. Dupont 25P at 3.0 to 4.0 mils DFT

One Coat
1. Tnemec 29 Tufcryl at 2.0 to 3.0 mils DFT
2. Ameron Amerlock 400 at 2.0 to 4.0 mils DFT
3. Dupont High Solids Acrylic Coating 3.0 mils DFT

7. Interior Exposed Steel, Joists, Ductwork, Conduit and Similar Items (where indicated):

One Coat
1. Tnemec Series 115 WB Unibond or Series 15 Unibond at 2.5 to 3 mils DFT
2. Ameron Amercoat 220 Acrylic Series at 3.0 mils DFT

8. Mechanical Room Floor, Epoxy System:

One Coat
1. Tnemec Series 201/203 Epoxoprime at 4.0 to 6.0 mils DFT
2. Ameron Amerlock Seal at 1.0 to 1.5 mils DFT

One Coat
1. Tnemec Series 206 Flexible Epoxy Underlayment at 50 to 80 mils DFT
2. Ameron NU-Klad 126 at 30 to 40 mils DFT

One Coat
1. Tnemec Series 297 at 3 mils DFT
2. Ameron PSX-700 Series at 3.0 to 5.0 mils DFT

9. Exposed Concrete Floor Sealer:

One Coat
1. Ashford Formula by Curecrete Chemical
2. Chem Probe CT Denisifyer
3. Degussa R41 Sealer
4. Ameron NU-Klad 126 or Amerlock Sear at 1.0 to 1.5 mils DFT

10. Mechanical and Electrical Work (Paint all exposed items throughout the project except factory finished items with factory-applied baked enamel finishes which occur in mechanical rooms or areas, and excepting chrome or nickel plating, stainless steel, and aluminum other than mill finished. Paint all exposed ductwork and inner portion of all ductwork: Same as specified for other interior metals, hereinabove.

E. Apply paint materials to surfaces as scheduled in the Standard Construction Specifications and as follows:

1. For Bridge Superstructure: Organic Zinc Rich Primer/Epoxy or urethane intermediate/Aliphatic Urethane Finish

2. Number of Coats..... 3

3. Surface Pretreatment.....High-Pressure Wash

4. Surface Preparation.....SSPC-SP10

5. Primer..... Organic Zinc Rich Primer as per Primer Data Sheet

6. Intermediate: Epoxy or urethane intermediate ..... Data Sheet

7. Finish: High-Build Aliphatic Urethane ..... Data Sheet

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Separate measurement will not be made for painting of bridge structures, but all costs in connection therefore shall be included in the Contract Lump Sum Prices bid as identified below, complete in place, including all preparation, accessories and incidentals.

B. Separate measurement shall not be made for painting of galvanized structural steel or miscellaneous metal required for use in construction of the South Acton station but will be included in the items to which it pertains.

4.2 PAYMENT

A. Payment for painting will be made at the Contract unit price for the quantities as specified above.

B. Payment for painting of the Sudbury River Bridge (MP 20.48) will be made at the Contract Unit Lump sum price for Item 0990.525 - Painting Bridge No.1, as specified above. Payment shall constitute full compensation for preparation/cleaning and painting of all steel bridge superstructures including but not limited to, girders, bearings, diaphragms, cross frames, bracing, and utility supports. This item also includes the implementation of worker protection programs, environmental protection, containment of the work and waste disposal.

C. Payment for painting of the Assabet River Bridge (MP 21.76) will be made at the Contract Unit Lump sum price for Item 0990.526 - Painting Bridge No.2, as specified above. Payment shall constitute full compensation for preparation/cleaning and painting of all steel bridge superstructures including but not limited to, girders, bearings, diaphragms, cross frames, bracing, ballast deck plate, drainage systems, and utility supports. This item also includes the implementation of worker protection programs, environmental protection, containment of the work and waste disposal.

D. Payment for painting of the Mill Pond Bridge (MP 40.01) will be made at the Contract Unit Lump sum price for Item 0990.527 - Painting Bridge No.3, as specified above. Payment shall constitute full compensation for preparation/cleaning and painting of all steel bridge superstructures including but not limited to, girders, bearings, diaphragms, cross frames, bracing, ballast deck plate, and drainage systems. This item also includes the implementation of worker protection programs, environmental protection, containment of the work and waste disposal.

E. Payment for painting of exposed items and surfaces at the South Acton Station will be included as an integral part of the work of Item 0211.615 Pedestrian Overpass, Item No. 0613.019 Access Platform, and Item No. 0613.020 Platform Canopy. Payment shall constitute full compensation for preparation/cleaning and painting of all exposed items and surfaces including but not limited to railings, supports, doors, frames, and other exposed station elements. This item also includes the implementation of worker protection programs, environmental protection, containment of the work, and waste disposal.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0211.615	PEDESTRIAN OVERPASS	LS
0613.019	ACCESS PLATFORM	LS
0613.020	PLATFORM CANOPY	SF
0990.525	PAINTING BRIDGE NO. 1	LS
0990.526	PAINTING BRIDGE NO. 2	LS
0990.527	PAINTING BRIDGE NO. 3	LS

END OF SECTION

SECTION 09910

SHOP PAINTING OF HOT-DIPPED GALVANIZED STEEL

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies substrate surface preparation and shop applied paint systems for structural steel and miscellaneous steel elements which have been hot-dip galvanized and will be exposed to view.

B. Definition: Paint shall be defined as liquid coating applied to the substrate surface by means of conventional air spray, airless spray, brush, or roller which dries or cures to a hard surface, and includes the words paint, primer, coating, and words of similar import.

1.2 QUALITY CONTROL

A. Abbreviations:

1. SSPC - Steel Structures Painting Council.

2. NFPA - National Fire Protection Association.

3. OSHA - Occupational Safety and Health Administration.

B. Quality Control:

1. Requirements of Regulatory Agencies: Provide and apply materials complying with environmental requirements of authority having jurisdiction.

2. Pre-Construction Conference: A meeting shall be held with representatives of the Engineer, Design Engineer, Galvanizer, Fabricator and Painter to review conditions, application, inspection procedures and specification requirements herein.

3. Tolerances:

a. Thickness: Apply coating of specified dry film thickness (DFT) where thickness shall be absolute minimum coverage at any point of measurement as determined by the paint manufacturer.

C. Mock-Up Surfaces or Areas: A sample platform guard fence section shall be designated as control for color, texture, and application for the specified paint system. This item,

once accepted by the Design Engineer, shall be used as criteria for acceptance for similar items, which shall match accepted mock-up.

D. Certificates:

1. Provide certificates listing materials used in coating system and certify compliance with standards designated.

2. Provide certificates stating that materials provided comply with requirements of this Section.

1.3 SUBMITTALS

A. Color Selection:

1. Color shall be black selected from manufacturer's standard colors.

2. Submit color chips to the Design Engineer, minimum 3 inches by 5 inches, in accordance with material or finish schedule for selection of colors of each item designated to be painted.

B. Certificates: Submit notarized certificates complying with requirements of this Section.

1.4 APPLICATION CONDITIONS

A. Environmental Requirements:

1. Apply all intermediate and finish coatings under conditions within the following tolerances:

a. Air Temperature: Min. 50 deg. F to max. 90 deg. F.

b. Surface Temperature: Min. 50 deg. F to max. 100 deg. F.

c. Relative Humidity: Max. 65 percent.

2. Maintain surface dry and free from dust, dirt, oil, grease, or other contaminants.

3. Keep environment free of airborne dust and dirt until paint is dry.

4. To ensure compliance with this Specification, monitor all temperature and humidity levels continuously with a recording hydrothermograph with printed record available for review by the Contractor at any time during the Project.

5. Comply with all applicable federal, state, local, OSHA, EPA, and fire regulations for both spray and curing facilities.

6. Provide spray booth with a filtered exhaust.

7. Cure booth may be heated to accelerate paint dry time at applicators option, however strictly comply with paint manufacturer's instructions. Temperature shall not exceed 150°F. Use an indirect thermostat controlled gas-fired, forced hot-air blower; do not use infra-red type curing equipment.

8. Protect spray and curing booth with sprinkler system complying with NFPA 15.

9. Continuously monitor air in curing booth by a lower explosive limit (LEL) monitoring device connected to the ventilation system.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide thinners, driers, and other products manufactured, furnished, or approved by accepted manufacturers for use with their product.

B. Handle, store, mix, and apply paint materials, primers, and metal conditioners in accordance with recommendations of accepted manufacturers.

C. Should it appear that conflicts exist between such recommendations and the Specifications, obtain written clarification from the Design Engineer before proceeding with the work.

2.2 COLORS

A. Color shall be black as selected from manufacturer's standard colors by the Design Engineer.

B. Provide finish coat color matching accepted color sample within industry tolerances and identified as specified.

2.3 PAINT MATERIALS

A. Priming and Color Coating of Galvanized Steel Members:

1. All steel that has been hot dipped galvanized after fabrication and is specified to be painted, shall receive a shop applied tie coat and finish color coat as indicated herein. Tie coat and finish color coat shall be by the same manufacturer.

   a. Epoxy Intermediate Coat: Tie coat shall be epoxy polyamide formulated for compatibility with newly galvanized surfaces and be equal to Tnemec 27 FC

TyPoxy, Dupont Colar 525TL, or Hempel Hempadur 4563. Dry film thickness shall be 2-3 mils.

b. Polyurethane Top Coat: Top coat applied over epoxy tie coat shall be Acrylic Polyurethane Enamel equal to Tnemec Series 74 Endura Shield III, Dupont Imron 333 or Hempel's 551U Urethane. Dry film thickness shall be 1.5 -2.5 mils.

2. Scope of Work:

a. Epoxy Intermediate Coating and Polyurethane Color Coating: Miscellaneous metal items specified herein that shall have epoxy intermediate coating and polyurethane color coating shall include ornamental fences, steel signage frames, parking paybox frames, light poles, structural steel and miscellaneous metals of station canopies, platform guard fences, handrail support brackets, and bridge walkway members and railings, brick lintels and relieving angles exposed to view and other galvanized miscellaneous items noted on drawings to be painted.

PART 3 – EXECUTION

3.1 SURFACE PREPARATION

A. All hot dip galvanized material shall be cleaned in accordance with Steel Structure Painting Council Specification SSPC-SP-1, Solvent Wipe followed by SSPC-SP-7, Brush-off Blast Cleaning, or SSPC-SP-3 Power Tool Cleaning to produce minimum 1-1.5 mil profile. Following completion of cleaning procedures and prior to application of coating material the galvanized material shall be visually inspected to determine complete absence of contaminants and that proper tooth or profile exists for paint adhesion.

B. The cleaning procedures shall be performed carefully so that the galvanized thickness does not fall below the required 3.4-3.9 mil zinc thickness.

3.2 INSPECTION

A. Examine material upon which work specified in this Section is dependent for defects which may influence application or installation and performance.

B. Do not place work in this Section upon previously placed incomplete, unsound, or defective work.

3.3 APPLICATION

A. Coating materials, specified herein, shall be applied by the galvanizer or an approved steel fabricator in strict conformance to requirements as specified in this Section.

B. Application: Intermediate tie coat shall be factory applied over cleaned galvanized members within 12 hours of surface preparation to prevent formation of unwelcome films. Top coatings shall be applied over intermediate coat in strict compliance with paint coat manufacturer's written recommendations. Top coating may also be field applied in accordance with Section 09900.

3.4 QUALITY CONTROL

A. Inspection:

1. Measure representative areas for DFT.

2. If thickness of coating does not comply with DFT requirements, apply additional applications of coating to attain specified DFT.

3. Where characteristics of coating prohibit recoating, remove and replace unacceptable coating.

4. Where application of coating exceeds DFT and is considered detrimental to quality of Project, remove and recoat to specified DFT.

5. Where measurement DFT is impractical or impossible, determine the amount DFT.

6. The manufacturer's stock and batch number will be compared with the assigned Paint Identification Number with the color sample submitted for finished surfaces, and with mock-up for finished surfaces in accordance with requirements of this Section.

3.5 FIELD REPAIR PROCEDURES

A. Where factory applied coatings have become damaged or abraded due to handling, transport, installation, welding or other circumstances, they shall be repaired by the field painting crew of the miscellaneous metal contractor.

B. All damaged areas shall be thoroughly wire brushed. All dirt, oil, grease, oxidation or other contaminants shall be removed. Touch-up paint supplied by the galvanizer or steel fabricator, identical in color and composition to that used in the plant, shall be applied to all prepared surfaces to a dry film thickness of at least 3.0 mils.

END OF SECTION

SECTION 10422

FIBERGLASS SIGNAGE

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies fiberglass signage as indicated on the Drawings and specified herein.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 05500 - MISCELLANEOUS METALS; Frames and supports not integral with signage.
2. Section 07920 – JOINT SEALERS, for requirements for sealants installed at perimeter of sign panels.
3. Section 10426 - TACTILE/BRAILLE SIGNAGE.

C. Permits: Obtain permits required by Local Authorities for installation of signs.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's product data, installation instructions, use limitations and recommendations for each material used. Provide manufacturer's certification stating that materials comply with requirements.

B. Shop Drawings: Provide large scale shop drawings for fabrication and installation of each sign type including mounting. Provide large scale layouts of sign wording, spacing, type size and style. Provide plans, elevations, and details of anchorage, connections and accessory items. Provide installation templates for work installed by others.

C. Templates: Submit full size templates or film positives for all messages and graphics for all Sign Types. Outline drawings of letterforms will not be accepted as templates.

D. Sign Schedules: Submit complete Sign Schedule for each sign. Use same designation as on the Drawings.

E. Samples for Approval: Sample Submittals are in addition to quantities shown in sign schedule. They are record project samples to be kept on file at the Engineer's office.

1. For each typestyle specified submit full samples of all alphabets, including numbers and punctuation, on 11 inch by 17 inch photostats and samples of standard letter spacing and word spacing (at min. of 3/4 inch cap height) for approval prior to fabrication.
2. Submit artwork of all symbols and logos to be used on 11 inch by 17 inch Photostats for approval prior to fabrication.
3. Submit samples of colors on all substrates specified for each Sign Type.

1.3 QUALITY ASSURANCE

A. MBTA Reference Standard: Comply with the MBTA, Guidelines and Standards, Part V, Graphics, Revised Fall 1990 with 1995 Supplement. A copy can be viewed or supplied on request to the MBTA Design Department, 500 Arborway, Jamaica Plain, MA 617-222-5044.

B. Reference Standards: The work shall conform to the codes and standards of the following agencies as further cited herein:

1. ADAAG: Americans with Disabilities Act Accessibility Guidelines
2. ANSI: American National Standards Institute.
3. ASTM: American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103 as published in "Compilation of ASTM Standards in Building Codes".
4. MAAB: Massachusetts Architectural Access Board.

C. Source: For each type of material required for the work of this section, provide primary materials which are the products of one manufacturer. Provide secondary materials which are acceptable to the manufacturers of the primary materials.

D. Accessibility: The ADAAG and the MAAB regulations are pertinent to the design and installation of items covered under the work of this Section. When guidelines conflict, the guideline giving greater access shall be applicable.

E. The approved manufacturer shall have experience in the type of work required, shall have a reputation for doing satisfactory work on time; and shall have recently successfully completed similar work.

F. The Contractor is responsible for the proper engineering of all items. The internal structure, dimensions and specifications for all items shall be indicated in the Contractor's shop drawings. Sign Contractor to engineer signs to proper level to withstand abuses of their environment.

G. Coordination: The work in this Section shall be completely coordinated with the work of other Sections. Verify dimensions and work of other trades that adjoin materials of this Section before the installation of items herein specified. Cooperate with such trades to assure the steady progress of all work under this Contract.

H. Hold Points - Mockups: Provide one full size mock-up in place of each type of signage.

1. If Engineer determines mockups do not comply with requirements, provide new identification device until mockups are approved.
2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver and store work under this Section in a manner to prevent cracking or stress of components and to prevent mechanical damage or damage by the elements.

B. Deliver work under this Section to Site in ample time to avoid delay in job progress and at such times as to permit proper coordination of the various parts.

C. Delay installation of this work until near time of Substantial Completion.

1.5 PROJECT CONDITIONS

A. Inspection of Site: The Contractor shall visit the site of the proposed work and fully acquaint himself with existing conditions and fully inform himself as to the facilities involved and the difficulties and restrictions attending the performance of the Contract, prior to submitting his price quotation.

B. Substrates: Proceed with work of this Section only when substrate construction and penetration work have been completed.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Fiberglass Sign Manufacturers: Provide products of one of the following manufacturers if they meet or exceed the requirements of these specifications:

1. Andco Industries Corp.
2. A.R.K. Ramos Manufacturing Company, Inc.
3. Best Manufacturing Co.
4. Gemini, Inc.
5. Lake Shore Markers.
6. Metal Arts, Division of L & H Manufacturing Co.
7. OMC Industries, Inc.
8. The Southwell Company.

2.2 MATERIALS

A. Steel:
   1. Structural steel materials, details and workmanship shall conform to the requirements of Section 05100 – Structural Steel.

B. Aluminum: Alloy 6063-T5, urethane finish.

C. Plywood: APA Graded, Exterior Grade A-C Plywood and Marine Grade Plywood, as required.

D. Fiberglass:

   1. Cast Fiberglass reproductions shall be a one-piece fiberglass and galvanized steel reinforced polyester resin casting with a minimum wall thickness of 1/4 inch. The casting shall be done with a full-scale urethane rubber mold.
   2. Fiberglass shall be constructed of low shrink, thermosetting polyester resins, reinforced with a quantity of glass fibers that measures no less than 30 percent by weight, in conformity with industry standards of the Society of Plastics. All fiberglass signs shall exhibit the following physical properties:
      a. Flexural Strength: 16,000 - 28,000 psi
      b. Tensile Strength: 9,000 - 18,000 psi
      c. Compressive Strength: 13,000 - 17,000 psi
      d. Specific Gravity: 1.4 - 1.6
      e. Chemical Resistance: will not be affected by mild soaps, detergents, alkalis, oils, carbon tetrachloride or weak acids.

f. Temperature Resistance: will remain strong and firm without warping, cracking or distorting at 200°F; below 32°F strength will increase a minimum of 50%.
g. Weather Resistance: shall retain surface integrity under all weather conditions of sunlight, rain, snow, sleet, hail and windblown sand or dirt.

E. Hardware:

1. Tamper resistant fasteners to be stainless steel, 3/8" diameter button head Phillips socket pinhead.
2. High strength bolts other than anchor bolts, nuts and washers shall conform to ASTM-A325.
3. Threaded studs shall be low carbon mild steel with a minimum yield strength of 50,000 PSI.
4. All hardware shall be galvanized per ASTM-A153 requirements.
5. Where mechanical fasteners and hardware are required, they shall be of adequate thickness, length and construction to properly secure the sign unit. Any visible portion of any mounting device shall be finished to match adjacent sign surface, unless otherwise specified.
6. Metal fasteners and hardware in contact with dissimilar metals shall have a protective coating or neoprene shields to prevent electrolytic action.

F. Adhesives:

1. Where adhesive mounting techniques are specified, the Contractor shall use adhesives specifically designed for compatibility with the base materials and the desired adhesive strength. All adhesives shall be tested on site. All adhesives shall be indicated in the shop drawings.
2. Surfaces on which signage is to be installed using adhesive shall be free of grease, oil, or any other residue.
3. Foam tape shall be 1/32" thick, high density open cell double coated polyurethane foam tape.
4. Very high bond (VHB) tape shall be double coated acrylic foam tape.
5. Provide necessary amounts of clear silicone sealant or grout for use in pin mounting.

G. Silk Screening:

1. Screen printed text and symbols shall utilize photographically prepared screens and shall be printed in accordance with accepted industry standards. No hand-cut screens will be accepted. All screen printing shall be executed in such a manner that all edges and corners of letterforms are true and clean. Letterforms, color areas, or lines with rounded positive or negative corners, built-up edges, bleeding, spattering, etc. will not be accepted. All photoscreens shall be prepared from typesetter's reproduction of the text specified, or camera ready artwork. All artwork and typesetting shall be no less than 50% of actual specified size. All inks shall be applied evenly without pinholes, scratches, orange peeling, etc.
2. All silk screening processes shall be approved by the Engineer prior to fabrication.

H. Typeface:

1. All vinyl and painted copy shall be in the following typefaces to match the letterforms shown in the Detail Drawings:
   a. Univers Bold
   b. Century Old Style Reg.
   c. Century Old Style Italic
   d. Garamond
   e. Celestia Antique Italic
   f. Sabon Bold

g. Sabon Roman
h. Helvetica Medium
i. Helvetica Bold

2. All graphics shall be made with the font specified using a link to the final graphic output device.

I. Typesetting:

1. All typeset messages shall be prepared on a computer. Letterforms shall match the samples shown in the drawings. Output for photographic reproduction shall be 2400 dots per inch. No typesetters' proofs shall be enlarged more than three times for use as graphics.
2. Standard letter spacing and standard word spacing shall be approved by Engineer for all fonts before final manufacture.
3. Typical type and symbol layout for each sign type is indicated on the Drawings. All type shall be placed according to the dimensions shown on the drawings. Should any design conflict occur in the fabrication of the signs; i.e., type not fitting, it shall be brought to the attention of the Engineer.

2.3 FABRICATION

A. Fabricate work to be truly straight, plumb, level and square with smooth flat surfaces and sharp corners, except where indicated otherwise.

B. Precisely form work to sizes, shapes, and profiles indicated on approved shop drawings.

C. Fabricate work with uniform joints that are not visible.

PART 3 - EXECUTION

3.1 INSPECTION

A. The Installer shall examine substrates, supports, and conditions under which this work is to be performed and notify Contractor, in writing, of conditions detrimental to the proper completion of the work. Do not proceed with work until unsatisfactory conditions are corrected. Beginning work means Installer accepts substrates and conditions.

B. Notification Point - Work shall be subject to inspection and approval by the Engineer in the shop or field at any reasonable time. Provide at least 72 hours notice for Engineer's inspection of complete fabricated signs before delivery.

3.2 INSTALLATION/APPLICATION/ERECTION

A. Strictly comply with approved shop drawings and manufacturer's instructions and recommendations, except where more restrictive requirements are specified in this Section.

B. Install work plumb, level, in true plane and alignment. Provide signs and graphics where shown or scheduled using mounting methods indicated.

C. Protect adjacent or adjoining surfaces and work from damage during installation in this Section.

D. Work shall be designed and anchored so that work will not be distorted nor the fasteners overstressed from expansion and contraction of metal or other materials as applicable.

3.3 TOLERANCES

A. The following allowable installed tolerances are allowable variations from locations and dimensions indicated by the Contract Document and shall not be added to allowable tolerances indicated for other work:

1. Allowable Variation from True Plumb, Level and Line: Plus or minus 1/16 inch from true position for signage smaller than 24 by 24 inches in size; plus or minus 1/8 inch from true position for signage 24 by 24 inches in size and larger.
2. Allowable Variation from True Plane of Adjacent Surfaces: Plus or minus 1/16 inch.

3.4 CLEANING AND PROTECTION

A. Adjust work to present the best possible appearance. Touch-up damaged finishes and repair damage to eliminate evidence of repair. Clean exposed surfaces using materials and methods recommended by manufacturer of material or product being cleaned. Remove and replace work that cannot be successfully repaired or cleaned.

B. Provide temporary protection to ensure work being without damage or deterioration at time of final acceptance. Remove protections and reclean as necessary immediately before final acceptance.

C. Manufacturer shall provide Authority with information on cleaning and maintenance recommendations for all signs.

D. Names, stamps and decals of manufacturers, installers or maintainers of signs shall not be visible in the finished work.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Fiberglass Signage for Display/Signs Type A and A1 along the station platforms, will be measured per each Station Sign – Type A, complete in place including signs, benches, framing, supports and all other accessories and incidentals.

B. Fiberglass Signage for Display/Signs Type B along the station platforms and walkways, will be measured per each Station Sign – Type B, complete in place including signs, benches, framing, roof structure, supports and all other accessories and incidentals.

C. Fiberglass Signage for Display/Signs Type C and C1 along the station platforms and walkways will be measured per each Station Sign – Type C, complete in place including benches, framing, supports and all other accessories and incidentals.

D. Fiberglass Signage for Display/Signs Type D along the station platforms will be measured per each Station Sign – Type D, complete in place including signs, schedule cases, benches, framing, supports and all other accessories and incidentals.

E. Fiberglass Signage for Display/Signs Type E and E1 along the station platforms and walkways will be measured per each Station Sign – Type E, complete in place including signs, framing, supports and all other accessories and incidentals.

F. Fiberglass Signage for Display/Signs within passenger shelters will be measured per each Station Sign – Type C, complete in place including benches, framing, supports and all other accessories and incidentals.

G. Separate measurement and payment will not be made for all other fiberglass signs, including Tactile Braille signs, but all costs in connection therefore shall be included in the Lump Sum price for Item No. 1041.550 - Station Sign.

4.2 PAYMENT

A. Payment for fiberglass signs will be made at the Contract Unit and Lump Sum Prices for the quantities as specified above.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
1041.501	STATION SIGN – TYPE A	EA
1041.502	STATION SIGN – TYPE B	EA
1041.503	STATION SIGN – TYPE C	EA
1041.504	STATION SIGN – TYPE D	EA
1041.505	STATION SIGN – TYPE E	EA
1041.550	STATION SIGN	LS

END OF SECTION

SECTION 10426

TACTILE/BRAILLE SIGNAGE

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies tactile/braille signage as indicated on the Drawings and specified herein.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 05500 - MISCELLANEOUS METALS; Frames and supports not integral with signage.
2. Section 10422 - FIBERGLASS SIGNAGE.

C. Permits: Obtain permits required by Local Authorities for installation of signs.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's product data, installation instructions, use limitations and recommendations for each material used. Provide manufacturer's certification stating that materials comply with requirements.

B. Shop Drawings: Provide large scale shop drawings for fabrication and installation of each sign type including mounting. Provide large scale layouts of sign wording, spacing, type size and style. Provide plans, elevations, and details of anchorage, connections and accessory items. Provide installation templates for work installed by others.

C. Templates: Submit full size templates or film positives for all messages and graphics for all Sign Types. Outline drawings of letterforms will not be accepted as templates.

D. Sign Schedules: Submit complete Sign Schedule for each sign. Use same designation as on the Drawings.

E. Samples for Approval: Sample Submittals are in addition to quantities shown in sign schedule. They are record project samples to be kept on file at the Engineer's office.

1. For each typestyle specified submit full samples of all alphabets, including numbers and punctuation, on 11 inch by 17 inch photostats and samples of standard letter spacing and word spacing (at min. of 3/4 inch cap height) for approval prior to fabrication.
2. Submit artwork of all symbols and logos to be used on 11 inch by 17 inch Photostats for approval prior to fabrication.
3. Submit samples of colors on all substrates specified for each Sign Type.

1.3 QUALITY ASSURANCE

A. MBTA Reference Standard: Comply with the MBTA, Guidelines and Standards, Part V, Graphics, Revised Fall 1990 with 1995 Supplement. A copy can be viewed or supplied on request to the MBTA Design Department, 500 Arborway, Jamaica Plain, MA 617-222-5044.

B. Reference Standards: The work shall conform to the codes and standards of the following agencies as further cited herein:

1. ADAAG: Americans with Disabilities Act Accessibility Guidelines
2. ANSI: American National Standards Institute.
3. ASTM: American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103 as published in "Compilation of ASTM Standards in Building Codes".
4. MAAB: Massachusetts Architectural Access Board.

C. Source: For each type of material required for the work of this section, provide primary materials which are the products of one manufacturer. Provide secondary materials which are acceptable to the manufacturers of the primary materials.

D. Accessibility: The ADAAG and the MAAB regulations are pertinent to the design and installation of items covered under the work of this Section. When guidelines conflict, the guideline giving greater access shall be applicable.

E. The approved manufacturer shall have experience in the type of work required, shall have a reputation for doing satisfactory work on time; and shall have recently successfully completed similar work.

F. The Contractor is responsible for the proper engineering of all items. The internal structure, dimensions and specifications for all items shall be indicated in the Contractor's shop drawings. Sign Contractor to engineer signs to proper level to withstand abuses of their environment.

G. Coordination: The work in this Section shall be completely coordinated with the work of other Sections. Verify dimensions and work of other trades that adjoin materials of this Section before the installation of items herein specified. Cooperate with such trades to assure the steady progress of all work under this Contract.

H. Hold Points - Mockups: Provide one full size mock-up in place of each type of signage.

1. If Engineer determines mockups do not comply with requirements, provide new identification device until mockups are approved.
2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver and store work under this Section in a manner to prevent cracking or stress of components and to prevent mechanical damage or damage by the elements.

B. Deliver work under this Section to Site in ample time to avoid delay in job progress and at such times as to permit proper coordination of the various parts.

C. Delay installation of this work until near time of Substantial Completion.

1.5 PROJECT CONDITIONS

A. Inspection of Site: The Contractor shall visit the site of the proposed work and fully acquaint himself with existing conditions and fully inform himself as to the facilities involved and the difficulties and restrictions attending the performance of the Contract, prior to submitting his price quotation.

B. Substrates: Proceed with work of this Section only when substrate construction and penetration work have been completed.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Tactile/Braille Sign Manufacturers: Provide products of one of the following manufacturers if they meet or exceed the requirements of these specifications:

1. Andco Industries Corp.
2. A.R.K. Ramos Manufacturing Company, Inc.
3. ASI Sign Systems.
4. Best Manufacturing Co.
5. Gemini, Inc.
6. Lake Shore Markers.
7. Metal Arts, Division of L & H Manufacturing Co.
8. OMC Industries, Inc.
9. The Southwell Company.

2.2 MATERIALS

A. Aluminum Frames: Alloy 6063-T5, urethane finish.

B. Plastic Laminate: Provide high pressure laminate engraving stock, with face and core plies in contrasting colors, in finishes and color combinations as selected by Engineer from manufacturer's full range.

C. Cast Acrylic Sheet: Provide cast (not extruded or continuous cast) methyl methacrylate monomer plastic sheet, in sizes and thicknesses indicated, with a minimum flexural strength of 16,000 psi when tested according to ASTM D 790, with a minimum allowable continuous service temperature of 176 deg F, and of the following general types:

1. Transparent Sheet: Where sheet material is indicated as "clear," provide colorless sheet in matte finish, with light Transmittance of 92 percent, when tested according to the requirements of ASTM D 1003.
2. White Translucent Sheet: Where sheet material is indicated as "white," provide white translucent sheet of density required to produce uniform brightness and minimum halation effects.
3. Opaque Sheet: Where sheet material is indicated as "opaque," provide colored opaque acrylic sheet in colors and finishes as selected by Engineer

D. Hardware:

1. Tamper resistant fasteners to be stainless steel, 3/8" dia. button head Phillips socket pinhead.
2. High strength bolts other than anchor bolts, nuts and washers shall conform to ASTM-A325.
3. Threaded studs shall be low carbon mild steel with a minimum yield strength of 50,000 PSI.
4. All hardware shall be galvanized per ASTM-A153 requirements.
5. Where mechanical fasteners and hardware are required, they shall be of adequate thickness, length and construction to properly secure the sign unit. Any visible portion of any mounting device shall be finished to match adjacent sign surface, unless otherwise specified.
6. Metal fasteners and hardware in contact with dissimilar metals shall have a protective coating or neoprene shields to prevent electrolytic action.

E. Adhesives:

1. Where adhesive mounting techniques are specified, the Contractor shall use adhesives specifically designed for compatibility with the base materials and the desired adhesive strength. All adhesives shall be tested on site. All adhesives shall be indicated in the shop drawings.
2. Surfaces on which signage is to be installed using adhesive shall be free of grease, oil, or any other residue.
3. Foam tape shall be 1/32" thick, high density open cell double coated polyurethane foam tape.
4. Very high bond (VHB) tape shall be double coated acrylic foam tape.
5. Provide necessary amounts of clear silicone sealant or grout for use in pin mounting.

F. Silk Screening:

1. Screen printed text and symbols shall utilize photographically prepared screens and shall be printed in accordance with accepted industry standards. No hand-cut screens will be accepted. All screen printing shall be executed in such a manner that all edges and corners of letterforms are true and clean. Letterforms, color areas, or lines with rounded positive or negative corners, built-up edges, bleeding, spattering, etc. will not be accepted. All photoscreens shall be prepared from typesetter's reproduction of the text specified, or camera ready artwork. All artwork and typesetting shall be no less than 50% of actual specified size. All inks shall be applied evenly without pinholes, scratches, orange peeling, etc.
2. All silk screening processes shall be approved by the Engineer prior to fabrication.

G. Typeface:

1. All vinyl and painted copy shall be in the following typefaces to match the letterforms shown in the Detail Drawings:
   a. Univers Bold
   b. Century Old Style Reg.
   c. Century Old Style Italic
   d. Garamond
   e. Celestia Antique Italic
   f. Sabon Bold
   g. Sabon Roman
   h. Helvetica Medium
   i. Helvetica Bold
2. All graphics shall be made with the font specified using a link to the final graphic output device.

H. Typesetting:

1. All typeset messages shall be prepared on a computer. Letterforms shall match the samples shown in the drawings. Output for photographic reproduction shall be 2400 dots per inch. No typesetters' proofs shall be enlarged more than three times for use as graphics.
2. Standard letter spacing and standard word spacing shall be approved by Engineer for all fonts before final manufacture.
3. Typical type and symbol layout for each sign type is indicated on the Drawings. All type shall be placed according to the dimensions shown on the drawings. Should any design conflict occur in the fabrication of the signs; i.e., type not fitting, it shall be brought to the attention of the Engineer.

2.3 FABRICATION

A. Acrylic or Plastic Laminate Panel Signs: Fabricate as follows:

1. Construction: Backplate, 1/8 in. acrylic or plastic laminate.
2. Raised Letter Construction: 1/32 in. routed letters permanently mounted to surface of plate.
3. Border Style: None (straight).
4. Background Texture: Smooth.
5. Edges: Eased.
6. Fasteners: Flexible self-adhesive.
7. Corners: Square.
8. Braille: Provide raised Grade 2 Braille on each sign, as required.

B. Acrylic Letterform Signs: Fabricate as follows:

1. Construction: 6 in. high, 1/2 in. deep acrylic.
2. Projection: 1 in.
3. Color: Integral black letters.

C. Fabricate work to be truly straight, plumb, level and square with smooth flat surfaces and sharp corners, except where indicated otherwise.

D. Precisely form work to sizes, shapes, and profiles indicated on approved shop drawings.

E. Fabricate work with uniform joints that are not visible.

PART 3 - EXECUTION

3.1 INSPECTION

A. The Installer shall examine substrates, supports, and conditions under which this work is to be performed and notify Contractor, in writing, of conditions detrimental to the proper completion of the work. Do not proceed with work until unsatisfactory conditions are corrected. Beginning work means Installer accepts substrates and conditions.

B. Notification Point - Work shall be subject to inspection and approval by the Engineer in the shop or field at any reasonable time. Provide at least 72 hours notice for Engineer's inspection of complete fabricated signs before delivery.

3.2 INSTALLATION/APPLICATION/ERECTION

A. Strictly comply with approved shop drawings and manufacturer's instructions and recommendations, except where more restrictive requirements are specified in this Section.

B. Install work plumb, level, in true plane and alignment. Provide signs and graphics where shown or scheduled using mounting methods indicated.

C. Protect adjacent or adjoining surfaces and work from damage during installation in this Section.

D. Work shall be designed and anchored so that work will not be distorted nor the fasteners overstressed from expansion and contraction of metal or other materials as applicable.

3.3 TOLERANCES

A. The following allowable installed tolerances are allowable variations from locations and dimensions indicated by the Contract Document and shall not be added to allowable tolerances indicated for other work:

1. Allowable Variation from True Plumb, Level and Line: Plus or minus 1/16 inch from true position for signage smaller than 24 by 24 inches in size; plus or minus 1/8 inch from true position for signage 24 by 24 inches in size and larger.
2. Allowable Variation from True Plane of Adjacent Surfaces: Plus or minus 1/16 inch.

3.4 CLEANING AND PROTECTION

A. Adjust work to present the best possible appearance. Touch-up damaged finishes and repair damage to eliminate evidence of repair. Clean exposed surfaces using materials and methods recommended by manufacturer of material or product being cleaned. Remove and replace work that cannot be successfully repaired or cleaned.

B. Provide temporary protection to ensure work being without damage or deterioration at time of final acceptance. Remove protections and reclean as necessary immediately before final acceptance.

C. Manufacturer shall provide Authority with information on cleaning and maintenance recommendations for all signs.

D. Names, stamps and decals of manufacturers, installers or maintainers of signs shall not be visible in the finished work.

3.5 SCHEDULES

A. Interior Signage Schedule: Provide signage at locations scheduled. Provide required signage at locations indicated on Drawings, or if not indicated, at the following locations:

1. Each room shall have a Room Number and Name sign; letter height 1 to 1-1 /2 inches.
2. Each floor shall be properly identified in stairways, at each level; letter height 3 to 4 inches.
3. Each floor shall be properly identified on elevator hoistway entrance jambs; letter height 4 inches.
4. Each floor shall have elevator safety signage; letter height 1 to 1-1 /2 inches.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

A. Separate measurement and payment will not be made for Tactile/Braille signage, but all costs in connection therefore shall be included in the Contract Lump Sum price for Item No. 1041.550 - Station Sign.

4.2 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
1041.550	STATION SIGN	LS

END OF SECTION

SECTION 10440
SIGNAGE

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies furnishing and installing aluminum signs and trailblazer signs, including supports, as indicated in the Contract Plans and as specified herein.

B. Temporary traffic signs required for construction shall be in accordance with Section 0150 – Traffic Regulation

C. All other Station related signs shall be in accordance with Sections 10422 - Fiberglass Signage and Section 10426 – Tactile/Braille Signage.

1.2 SUBMITTALS

A. Shop Drawings: Provide shop drawings for fabrication, installation and erection of all parts of the work. Provide plans, elevations and details of anchorages, connections and accessory items. Provide installation templates for work installed by others.

B. Take measurements in the field and verify all dimensions before submitting Shop Drawings.

C. Show in detail the various portions of the work, graphic and art layouts, kind of materials, size of members and method of securing same together and to work of other trades.

D. Where provisions must be made for attaching other materials to work included under this Section or where provisions must be made for assembly and installation in the field, the required cut outs and attachments shall be provided in the shop. All such items shall be indicated on the Shop Drawings.

1.3 SAMPLES OF MATERIALS

A. Initial Selection Samples: Submit minimum of six samples measuring 8 inch x 8 inch each showing complete range of colors, textures, and finishes available for each material used.

B. Verification Samples: Submit representative samples of each material that is to be exposed in the finished work, showing the full range of color and finish variations expected.

C. Full-size paper proofs of all signs, with proposed colors marked thereon.

D. The Engineer may inspect all material and workmanship at any time during the progress of the work and shall have the right to reject all material and workmanship that does not conform to the Specifications or that is not considered of adequate quality in terms of accuracy of registration, color, or coverage.

E. Manufacturer's Data

1. List manufacturer and branch name for each type and color of paint used.

1.4 COLOR SAMPLES

A. Colors shall be pure, non-fading pigments, mildew-proof, sun proof, finely ground in approved medium. Colors used shall be submitted on the respective material surfaces. The "Commuter Rail" purple paint color shall match Dupont Imron 1976.

1.5 QUALITY ASSURANCE

A. The approved manufacturer shall be experienced in the type of work required, shall have a reputation for doing satisfactory work on time, and shall have recently successfully completed similar work.

B. Deliver and store work under this signage in a manner to prevent cracking, chipping or stress of components, and to prevent mechanical damage or damage by the elements. Damaged items shall be removed and replaced as directed.

1.6 STANDARDS

A. Except as modified by governing codes and by the Contract documents, work shall comply with the applicable provisions and recommendations of the following:

1. The Commonwealth of Massachusetts, Massachusetts Highway Department Standard Specifications for Highways and Bridges, 1988 Edition, and its latest supplements, Sections 828 and 840 referred to as MHD.
2. U.S. Department of Transportation Federal Highway Administration Manual on Uniform Traffic Control Devices, 1978.
3. The Massachusetts Bay Transportation Authority Commuter Rail Design Standards.
4. The Massachusetts Bay Transportation Authority Guidelines and Standards, Part V-Graphics.

PART 2 - PRODUCTS

2.1 METAL SURFACES, GENERAL

A. Use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names, roughness, oil-canning stains, discoloration or other imperfections.

2.2 ALUMINUM SHEET

A. Aluminum shall be of thickness and sizes shown, constructed of 6063-T5 and 6061-T6 sheet and extrusions or other alloy as required to receive finishes indicated. Aluminum in contact with dissimilar metals shall have bituminous or other protective coating applied to the contact surface to prevent electrolytic action.

B. Where aluminum work is indicated to the standard manufacturer's item, construction shall be based on manufacturer's standard assembly. Where aluminum is shop fabricated, all joints, returns and the like shall be properly joined together and welded, ground smooth and finished with proper grit. All exposed welded edges

shall be ground smooth to proper natural aluminum finish. Welding rod shall be of same alloy as aluminum sheet.

2.3 PAINT

Paint shall meet the following requirements:

A. Suitable for exposure to severe weather conditions.

B. Strong, vivid, non-fading colors.

C. Semi-gloss finish.

2.4 SILK SCREENING

A. Screen printed text and symbols shall utilize photographically prepared screens and shall be printed in accordance with accepted industry standards. No handcut screens shall be accepted. All screen printing shall be executed in such a manner that all edges and corners of letterforms are true and clean. Letterforms, color areas, or lines with rounded positive or negative corners, built-up edges, bleeding, spattering, etc. will not be accepted. All screen printing shall be executed from photoscreens prepared from typesetter's reproduction of the text specified, or camera ready artwork. All artwork and typesetting shall be not less than 50% of actual specified size. All inks shall be applied evenly without pinholes, scratches, orange peeling, etc. Screen printing inks shall be fast drying enamel finish.

B. All silk screening processes shall be approved by the Engineer prior to fabrication. Masking shall be done carefully so as to not leave bleeding or rough edges at painted surfaces. Spray guns used for art work shall be airless type as approved. All graphic work shall receive at least two coats of paint.

2.5 TYPEFACES

A. Unless otherwise noted, typefaces shall be Helvetica medium and shall be industry standard normal letter spacing.

B. Typefaces and letter spacing shall be approved by the Engineer before final manufacture.

C. Typical type and symbols layout for each sign type is indicated on the Drawings. All type shall be placed according to the dimensions shown on the Drawings. Should any design conflict occur in the manufacture and fabrication of the signage; i.e., type not fitting, it shall be brought to the attention of the Engineer.

D. Application of all lettering, arrows, and other artwork shall be photographic silk screen. No modification of type faces or layout rules and the arrow/circle will be permitted without approval by the Engineer.

2.6 FABRICATION

A. General: Verify measurements and dimensions at the job site and cooperate in the coordination and scheduling of work of this Section with work of related trades, with particular attention given to installation of sign supports and framing.

B. Painted Aluminum Signs

1. Form aluminum work to the required shapes and sizes, with true curves, lines and angles as shown. Provide necessary lugs, rebates and brackets for assembly of units. Use concealed fasteners where possible.
2. Make all threaded connections tight so that threads are entirely concealed. Provide abutting bars which are shouldered and headed, doweled and pinned. Pass small bars through larger bars and pin. Provide flat and countersunk heads on rivets, bolts, and screws in exposed work and elsewhere as required. Carefully machine, fit and secure removable members by means of Allen set screws of proper size and spacing.
3. Aluminum signs shall be pretreated by solvent cleaning and a wash coat of basic zinc chromate-vinyl butyral conforming to MHD materials specification M.7.04.10.

2.7 NEW SIGN FRAMING

A. Fabrication of all required supporting and enclosing frames shall be in accordance with the Standards of Section 05500.

B. Provide complete shop drawings.

C. Framing shall be hot-dip galvanized after fabrication and touched-up as directed by the Engineer.

2.8 FASTENINGS AND ANCHORS

A. Design a complete system of fastenings and anchorage devices for the various signs, as required for attachment to the various supporting structures. These may include, but are not limited to, concealed clip systems, face screws, epoxy adhesives, etc. Wherever reasonably possible, fastenings and anchorage devices shall be fully concealed, and shall be vandal proof. The Contractor is responsible to provide safe and secure installation in strict conformance to the governing laws and building code.

B. Fully describe proposed fastenings and anchorage devices for each sign type on the shop drawings.

C. Hardware: Provide all necessary hardware required to complete the Work, and as follows:

1. Bolts, screws and miscellaneous fasteners: Brass or bronze.

2. Hangers, studs, clip angles, and filler plates: Commercial stock galvanized steel, M10-20.

3. Exposed fasteners: As indicated above, and tamper proof.

D. Plywood: Provide exterior grade marine plywood as graded by the American Plywood Association.

PART 3 - EXECUTION

3.1 ERECTION

A. Erection of work under this section shall be performed by experienced qualified sign erectors. Panels and signs shall be true, plumb and level, located as shown on the Drawings and set with true joints to the width as shown on the Drawings. Fastenings shall be concealed of the type shown on the Drawings or as approved and shall be stainless steel spanner head sheet metal screws located on the sign where shown.

B. Furnish and install shims, tabs, clips, screws, bolts, spacer sleeves, supports and all necessary items to make the complete installation. Upon completion of the installation, work shall be checked and readjusted as necessary.

C. Non-Shrink Construction Grout, as described in Section 03604, will be applied beneath the sign base plates and is included in the cost of the signs.

D. All free-standing sheet aluminum signs shall be mounted on a standard P-5 break-away post assembly, in accordance with MHD Section 840, as shown on the Contract Drawings.

E. Handicap signs are to be mounted on a standard P-5 post set as shown on the Contract Drawings.

F. The exact location of all signs will be determined by the Engineer.

3.2 CLEANING

A. Surfaces of sign work shall be cleaned as recommended by the sign manufacturer after installation and left in a condition satisfactory to the Engineer.

B. Fiberglass shall be in prime condition, free from dirt, scratches, handmarks and other blemishes.

C. Inspection shall be made by the Engineer to determine the condition of work. Damaged work, and work not in compliance with Contract Documents shall be rejected and replaced at no additional cost to the Authority.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Aluminum sign panels, including guide, traffic, parking, regulatory and trail blazer signs will be measured by the square foot of sign panel complete in place, including all accessories and incidentals.

B. P-5 Sign Support will be measured per each unit complete in place, including all accessories and incidentals.

4.2 PAYMENT

A. Payment for work under this Section will be made at the Contract Unit Prices for the quantities determined as specified above.

4.3 PAYMENT ITEMS

Item No.	Description	Unit
1041.262	TRAFFIC SIGN, ALUMINUM PANEL - TYPE A	SF
1041.336	P-5 SIGN SUPPORT	EA

END OF SECTION

SECTION 13100

PREFABRICATED STRUCTURES

PART 1 - GENERAL

1.1 DESCRIPTION

This Section specifies furnishing and installing prefabricated maintenance buildings and floor slabs at the proposed South Acton Station platforms, as described herein and as indicated on the Contract Drawings. The floor slab shall be a cast-in-place reinforced concrete slab, or a prefabricated floor slab provided as part of the prefabricated building.

1.2 QUALITY ASSURANCE

A. The maintenance building (10 feet x 16 feet), and the functioning of the equipment contained within shall be factory inspected and tested.

B. The Engineer shall inspect the maintenance building after it has been installed and the Contractor shall correct any deficiencies.

1.3 SUBMITTALS

A. The Contractor shall submit the following for approval:

1. Catalog cuts and descriptive literature for all material as specified herein and as shown on the Contract Drawings.
2. Drawings showing the proposed size, layout, electrical and grounding arrangement and detailed bill of material for the maintenance building.
3. Drawings of all hardware and door details.
4. Shop drawings and design calculations prepared by a professional Structural Engineer Registered in the State of Massachusetts for a concrete floor slab capable of supporting the weight of the building, and all applicable live loads, snow loads, wind loads, and earthquake loads. The contractor shall also submit to the engineer a means for affixing the building to the floor slab and the floor slab to the steel support frame as shown on the contract drawings.
5. Color choices for the overhead door, wall panels, roof, trim, and other exterior elements of the building.

1.4 DELIVERY, STORAGE AND HANDLING

A. All equipment shipped within the maintenance buildings shall be properly fastened and braced to prevent damage during transit.

B. All equipment shipped separately shall be properly packaged and protected to prevent damage during shipment.

C. Any damage incurred in transit or caused by mishandling shall be corrected by the Contractor at no additional cost to the Authority.

PART 2 - PRODUCTS

2.1 MAINTENANCE BUILDINGS

A. General

The size of the Maintenance Building shall be as a minimum that shown on the contract plans. The Maintenance Building shall come equipped with one (1) 8-foot wide by 8-foot tall, steel overhead door. The Maintenance Building shall be positioned on site so that the overhead door opens to the adjacent sidewalk.

B. Structural Requirements

1. The building shall be designed for the following loads, in addition to the stationary weight of the building:
   a. The snow load to be used for the building design shall be not less than 30 PSF.
   b. The standard wind load shall be not less than 21 PSF.
2. The building floor slab shall be designed for all applicable live loads, dead loads, snow loads, wind loads, and seismic loads for maintenance facilities as specified in the Massachusetts State Building Code 6th edition.
3. The building and floor slab shall be designed by a professional structural engineer registered in the state of Massachusetts, and all shop drawings and calculations shall bear his/her stamp and signature.

C. Materials

1. The maintenance building shall be constructed of structural steel framing and steel reinforced, polypropylene reinforced concrete. Concrete shall be 5000 PSI minimum 28-day compressive strength, air entrained (ASTM C260). Reinforcing steel shall be ASTM A615, Grade 60. Polypropylene fiber shall be a fiber mesh at 1.6 pounds per cubic yard.
2. Overhead doors shall be 18-guage steel, hinged, manual operation overhead doors.
3. Underground cable knockout entrance shall be provided behind the main Branch Circuit Panel board for providing electrical power to the building. The interior top and sides shall be lined with fire resistant insulating material with a minimum insulation value of R-19 complying with a flame spread of 0-20 and a fire rating of 7 in accordance with ASTM-E-84. Roof ventilation openings shall be provided as required for the size of the shelter the Contractor proposes.
4. The maintenance building shall be equipped with a minimum of two ventilation openings covered with fine mesh stainless steel. The exterior of the ventilation openings shall be hooded to minimize the entrance of precipitation. The interior of ventilation opening shall be equipped with a sliding steel plate to allow the adjustment of airflow. The overhead doors shall be provided with stainless steel locking handles with a three-point locking device that will ensure that the doors cannot be locked until they are in the fully closed position. Additional pad locks and appropriate appurtenances shall be provided to secure the overhead door to the building in the closed position.
5. Hinges shall be vandal proof, 3 per door welded to the housing and door. The hinges shall be equipped with bronze hinge pins and shall be lubricated by the manufacturer before the shelter is shipped.

D. Finishes

1. Wall panels shall have an exposed aggregate finish on all exterior walls, as approved by the engineer.
2. All interior surfaces shall have a smooth form finish.
3. The concrete roof shall have an architectural ribbed edge.

J. Cable Entrance Pipes. Cable entrance pipes shall be as specified in Section 16897.

K. Grounding Material. Grounding material shall be as specified in Section 16450. Shelters shall be furnished with two ground bus bars.

L. Wiring. Wiring shall be in accordance with Section 16050.

M. All equipment described in this Section shall be painted in accordance with AAR Signal Manual Part 2.4.30.

1. Steel doors and frames shall be bonderized and painted one coat of rust inhibited primer and one finish coat, color to be determined by the Engineer.

2.2 BUILDING UTILITIES

A. Branch Circuit Panel boards

1. The Maintenance Building shall be provided with one branch circuit panel board for power supply conforming to the requirements of Section 16050.
2. Power supply shall be brought into each maintenance building through the floor of the building through the cable entrance pipes located below the branch circuit panel board.

B. Lighting

1. Each Shed shall be provided with incandescent electric lights as required to provide complete illumination of 30 foot-candles minimum in all areas of the Shed. Lights shall be operated from wall mounted switches conveniently placed near each Shed door.

C. Convenience Outlets (Receptacles)

1. Three convenience outlets shall be furnished and installed along the perimeter walls of the Sheds, four feet above the floor. All receptacles shall have Ground Fault Circuit Interrupted (GFCI) protection.

D. Branch Circuit Wiring

1. Wiring for HVAC, lights, fan control and convenience outlets shall be minimum #14 AWG, flexible, THHN wire installed in Electrical Metallic Tubing (EMT).

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Maintenance Building floor slab shall be placed level and flat on a gravel base and compacted subgrade.

B. Sheds shall be set level, plumb, and secured to the floor slab.

C. Cable entrance pipes shall be installed through the cable knockout holes provided in the floor of the building below the branch circuit panel board.

D. The Maintenance building shall be grounded as specified in Section 16450.

E. Cables shall enter maintenance buildings by entrance knockouts and fittings and entrance pipes provided through the floor slab below the branch circuit panel board.

3.2 TESTS

A. The functioning of the equipment contained within the buildings shall be tested in accordance with the requirements of Section 16050 and the approved Installation Test Procedure.

3.3 PAINTING

A. Upon delivery, the Contractor shall assure the equipment has been properly painted in accordance with Article 2.01, paragraph M, of this Section and correct any deficiencies. In addition, one coat of paint shall be applied prior to placing in-service. The finish coat shall be as approved by the Authority.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

A. Separate measurement and payment will not be made for the work required under this Section, including the prefabricated shelter, reinforced concrete floor, steel frame supports, and all incidentals, but all costs in connection therefore shall be included in the Contract Lump Sum Price for Item 1365.000 Prefabricated Structures.

4.2 PAYMENT ITEM

ITEM	DESCRIPTION	UNIT
1365.000	PREFABRICATED STRUCTURES	LS

END OF SECTION

SECTION 14240

ELECTRIC TRACTION ELEVATORS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section

1.2 GENERAL DESCRIPTION

A.. This provides design guidelines for the fabrication, installation, and testing of Machine Room Less elevator.

B.. Related Sections include the following:

1. Section 03300 "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
2. Section 05120 "Structural Steel" for attachment plates, angle brackets, and other preparation of structural steel to support elevator equipment and components.
3. Section 08311 "Access Doors and Frames" for wall and ceiling access panels and access doors in elevator enclosures.
4. Division 16 Sections for electrical service to elevators, including disconnect switches.

1.3 DEFINITIONS

A. Heavy duty elevator: An elevator designed specifically for the harsh environment and duty load cycles common to transportation system usage.

B. Elevator - a hoisting and lowering mechanism, equipped with a car or platform, which moves in guide rails or racks and serves two or more landings.

C. Elevator, passenger - an elevator used primarily to carry persons other than the operator and persons necessary for loading and unloading.

D. Elevator, gearless- a traction machine, without intermediate gearing, that has the traction sheave and the brake drum mounted directly on the motor shaft.

E. Defective Elevator Work: Operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; the need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

F. Contractor: The General Contractor.

G. Installer: The responsible party who installs the elevator.

H. OEM: Original Equipment Manufacturer.

I. MBTA: The owner in control of the facility.

J. Dwell time: The period of time the elevator is at a landing while the doors open, passengers transfer and doors close.

K. Substantial completion: The point at which the elevator is ready for use, whether the site is finished or not. This is where the jurisdictional inspection usually takes place.

L. Final Acceptance: The point at which the MBTA accepts the elevator project as being complete including all submittal requirements. This may be different point in time than substantial completion.

M. Interim Maintenance: Maintenance from the point of substantial completion, but prior to Revenue Service.

N. Beneficial Use: When the elevator is placed into service, may be prior to the site being ready for public use.

O. Revenue Service: The station or facility opening date.

P.. Notice to Proceed (NTP): within this document shall mean the date which the elevator installer is notified to proceed with the project.

Q. Authority Having Jurisdiction (AHJ): as defined by ASME A17.1.

R. MBTA: Massachusetts Bay Transportation Authority

S. MSDS: Material Data Safety Sheets, as defined by OSHA

T.. OSHA: Occupational Safety and Health Administration

1.4 TEMPORARY AND PERMANENT ELECTRICAL POWER SERVICES

Contractor shall provide and coordinate the following:

A. Temporary power for installation shall be made available to Installer at the time of the installation. Permanent power shall be made available for testing. All power shall be provided at no cost to Installer.

B. For the elevator drive systems: 480, 3 phase, 3 wire, 60 Hertz terminating in a disconnect switch within sight of the controller.

C. For lighting and GFCI receptacles: 120 volts, 1 phase, 3 wire, 60 Hertz terminating at the elevator controller location.

D. Separate disconnect for cab lighting and wiring to cab: 120 volts, 1 phase, 3 wire, 60 Hertz terminating in a disconnect switch within sight of the controller.

E. Separate service for sill heaters, cab air conditioning, cab air conditioning evaporator and other ancillary elevator equipment, where required.

1.5 APPLICABLE CODES, STANDARDS, ORGANIZATIONS AND PUBLICATIONS

Elevator designs and installations shall be of the heavy duty type, and shall comply with the following:

A. American Society of Mechanical Engineers (ASME)

1. ASME A17.1 2004 and A17.1S-2005 with Addenda, A17.2.3, A17.5 (hereafter referred to as the code)

B. National Fire Protection Association (NFPA)

1. NFPA No. 130, "Fixed Guideway Transit and Passenger Rail Systems"

2. NFPA No. 13, 70 and 72

C. National Electrical Code (NEC)

D. Americans with Disabilities Act Accessibility Guidelines (ADAAG)

E. American Public Transit Association (APTA) Machine Room-Less (MRL) elevator design guidelines

F. IEEE 519 Standard Practices and Requirements for Harmonic Control in Electrical Power Systems

G. American Welding Society (AWS)

H. American Society of Testing and Material (ASTM)

I. International Standards Organization, ISO 281/1-1997 and later editions

J. American Federation of Bearing Manufacturers Association, AFBMA, Std. 9 and **11**

K. National Electrical Manufacturers Association (NEMA)

L. The American Insurance Association

M. Occupational Safety & Health Act (OSHA)

N. International Code Council/ American National Standards Institute, (ICC/ANSI), A117.1-2004

O. American Disabilities Accessibility Guidelines for Buildings and Facilities (ADAAG), 2004

P. Building Officials & Code Administrators International, Inc. (BOCA)

Q. Massachusetts Architectural Access Board (MAAB), 521 CMR 28.00

R. Massachusetts State Building Code, 780 CMR

S. Massachusetts Elevator Regulations, 524 CMR

T. Boston Center for Independent Living Agreement (BCIL)

U. Any additional requirements imposed by local agencies shall be incorporated into elevator installations.

V. In case of a conflict between codes, regulations, or standards, the most stringent requirement shall take precedence.

W. The elevator installer shall be licensed and strictly governed by local and governmental authorities of this area in order to perform this work.

1.6 SUBMITTALS

A. Submit OEM's product data and samples for the system proposed for use.

Product data shall include, but not be limited to the following:

1. Electrical characteristics and connection requirements.
2. Expected heat dissipation of elevator equipment in machine room and control areas (i.e. BTU's/hr.) based on 120 round trip cycles per hour.
3. Maintenance programs: within sixty (60) days after notice to proceed, and prior to installation, contractor shall submit detailed interim and revenue service maintenance programs, showing functions to be performed and their scheduled frequency.
4. Machine performance data sheets.
5. Pre-acceptance test forms.

B. Shop Drawings: Six (6) copies of the shop drawings shall be provided by the Installer. Submit approval layout drawings to scale. Drawings shall include, but not be limited to the following:

1. Car, guide rails, buffers and other components in hoistway.
2. Maximum rail bracket spacing.

3. Maximum loads imposed on guide rails requiring load transfer to the building structure.
4. loads on hoisting beams.
5. Clearances and travel of car and counterweight run by.
6. Clear inside hoistway and pit dimensions.
7. location and sizes of access doors, hoistway entrances and frames.
8. Car & Hall signal and operating fixtures.
9. Remote wiring layouts for each elevator
10. Refuge space on top of car and pit.
11. Control room, machine area, pit and hoistway layout.
12. Cab design, dimensions and layout.
13. Hoistway-door and frame details

C. Complete assembly detail of machine, machine mounting, machine beam assembly, dead end hitch and beam assemblies, governors, safeties, counterweights, with all load calculations.

D. Samples of materials and products requiring color or finish selection.

1.7 OPERATING AND MAINTENANCE MANUALS

A. Maintenance Manuals: Prior to installation, Contractor shall submit two (2) complete sets of operation and maintenance manuals for approval. After Engineer's approval and prior to the beginning of acceptance testing, four (4) sets of the approved manuals shall be provided by the Contractor. The manuals shall include the following:

1. Complete table of contents.
2. Complete instructions regarding operation and maintenance of the elevator equipment. Included will be complete illustrated, exploded views of all assemblies, and a complete, illustrated, exploded view for identifying all system parts.
3. Complete nomenclature of replaceable parts, part numbers, current cost, and warehouse location. If product source is another vendor, Contractor shall include name and address of other vendor.
4. Sample copies of a proposed preventive maintenance chart.
5. Descriptions of safety devices.
6. Safety rules, tests, and procedures, including testing of all systems and subsystems.
7. Procedures for adjusting all elevator components, including pictorials.
8. Troubleshooting techniques.
9. Detailed lubrication and cleaning schedule indicating weekly, monthly, quarterly, semiannual, and annual lubrication; and a description of each lubrication point, lubrication type, and specification.
10. Control and schematic electrical wiring diagrams of controller, including wiring of safety devices to connections with remote indication and control panels for the elevator.
11. Electrical layout showing placement of lighting, light switches receptacles, light fixtures disconnect switches, and convenience outlets in control areas, machinery spaces and pits.
12. Complete detailed drawings and wiring diagram of elevator system.

13. The Installer shall be required to provide certification, in writing and signed by an officer of the organization, that the MBTA shall be provided with copies of any and all information, correspondence, bulletins, newsletters, manuals, techniques, procedures, drawings, sketches and any other documents related to maintenance, safety, operations, design changes, modifications, retrofits, etc., which relate to any part, component, equipment, system, subsystem, or material and services applicable to the elevator provided.

    a. All of the above referenced shall be provided as it pertains to the original installation and for a period of ten (10) years after final acceptance of the elevator.

    b. The referenced material shall be provided within thirty (30) days of publication or internal distribution by the elevator manufacturer. The material, even if labeled PROPRIETARY, shall be delivered to the Engineer without prejudice or delay and at no additional cost.

14. The entire manual shall be also provided in an electronic format on CD-ROM that is acceptable to the Engineer.

15. MSDS and product data sheets: Shall be submitted with an index listing each product, along with the application method of the product, approximate quantity of product per elevator, and the component the product is applied to or associated with. The Installer shall allow 6 (six) weeks for review of MSDS

1.8 QUALITY ASSURANCE

A. OEM's Qualification: Regularly engaged for the past five years in the manufacture of major components for machine room-less (MRL) passenger elevators. As a standard of quality the elevator equipment design and installation shall comply with the code.

B. Installer's Qualifications: OEM's representative or authorized agent of elevator equipment OEM who is trained and approved for installation of units required for this Project.

C. Source Limitations: Obtain elevators through one source from a single manufacturing plant. Buy

American provisions are stipulated in the General Terms and Conditions of this Contract. Welding: Welding shall be performed in accordance with the requirements of AWS or CWB Welders shall produce evidence of current certification by AWS or CWB.

D. The elevator subcontractor shall guarantee the materials and workmanship of the apparatus furnished under these specifications and will make good any defects not due to ordinary wear and tear or improper use or careless, which may develop within one (1) year from date of completion of each elevator, inclusive of labor and traveling expenses.

E. Labeling Requirements: Every elevator shall be clearly marked with rate load and speed, manufacture serial number, and the designated MBTA's identification.

F. Requirements of Regulatory Agencies

    1. Application, Permits, Inspections, and Tests

        a. Contractor shall obtain and pay for all necessary permits, and perform such tests as may be required for acceptance and approval of elevators by jurisdictional agencies.

        b. Contractor shall notify the proper inspectors to witness required testing.

1.9 DELIVERY, STORAGE AND HANDLING

A. Store materials in original protective packaging in a dry and protected area.

B. Protect equipment exposed finishes during transportation storage and erection against damage and stains.

C. Deliver components with factory-installed wooden skids and lifting lugs; pack components in factory-fabricated protective containers.

D. Handle components carefully to avoid damage to components, enclosures, and finish.

E. Store components in clean, dry areas and protect them from weather. Storage shall be in areas designated by the Engineer.

F. Comply with the OEM's rigging instructions for unloading components; and moving components to their final location for installation.

1.10 ACCEPTANCE AND WARRANTY

A. The acceptance of the elevators is conditional upon the Contractor providing a written warranty that states that all equipment manufactured and installed by the Contractor under this specification, will be free of defects in design, materials, and workmanship, under normal use and service for a period of twelve (12) months from the date of Final Payment by the MBTA.

B. The warranty shall include all materials and labor necessary to correct defects that shall include, but not be limited to, noisy, rough, or substandard operation; loose, damaged, and missing parts; and fluid leaks.

C. Warranty Maintenance Requirements:

1. The installer shall provide twelve (12) months of preventive maintenance service to coincide with the warranty period.

2. The installer shall provide interim maintenance service from the time of initial elevator startup and testing to the time of final acceptance and payment. This service will be performed according to the approved maintenance plan tasks, with no extra charge to the MBTA for overtime required to return the elevator to service. Vandalism and acts beyond normal wear and tear are excluded.

3. This interim maintenance shall start at the final equipment acceptance and at the time of issuance of the Certificate for Operation by the State of Massachusetts Elevator Inspector. Interim maintenance shall be provided for a period of twelve (12) months as described below.

4. Deliverables: Proof of interim maintenance: documents will be required prior to Final Acceptance.

   a. Tasks:

      1. Inspection of completed installation and periodic testing to maintain elevator in completely operable condition.

      2. Operate each elevator at least monthly for a minimum of two (2) hours. (Total On-Site Time). Provide monthly documentation of the same to the MBTA.

      3. Periodic lubrication of parts and equipment components as per OEM's recommendation. Charts are to be provided for each elevator indicating when services are provided.

      4. Perform work without removing elevator from service during peak traffic periods between the hours of 6:00 a.m. to 9:00 am and 3:00 p.m. to 6:00 p.m.

      5. Provide twenty (24) hour emergency service during the maintenance period consisting of a prompt response (within 1 hour) to emergency request by telephone or otherwise from MBTA or designated representative if an elevator is inoperable or in case of injury, entrapment, or potential injury to persons.

6. Unlimited regular and overtime callbacks are included with a required response time of one (1) hour.

7. Annual clean down of the elevator and hoistway enclosure is required. Make necessary arrangements with MBTA in order to minimize any inconvenience.

b. Reporting: Detailed monthly records of tasks performed including names of individuals performing the tasks, date and time performed, and other pertinent data. Installer is required to conform to the requirements of the MBTA's data base maintenance system.

1.11 GUARANTEES

A. Notwithstanding the Specifications forming a part of this Contract, any inspection or approval of the Work by the Engineer, or the existence of any patent or trade name, the Contractor nevertheless unconditionally guarantees that the equipment furnished and installed hereunder shall be of the best quality and shall be fully fit for the purpose for which it is intended.

1.12 SPARE PARTS AND STOCK

A. Spare Parts: The Contractor shall provide the following listed spare parts upon the completion of the elevator installation:

1. Four (4) hoistway door rollers
2. Two (2) car door rollers
5. Four (4) hoistway door gibs
6. Four (4) cab door gibs
7. One (1) electronic door detector
8. One (1) set of replacement lights for the elevator cab
9. One (1) box of each type of fuses
10. Two (2) complete door interlock assemblies
11. One (1) door operator motor
12. Two (2) complete pushbutton assemblies for car operating station and hall stations

1.13 DESIGN CRITERIA

A. General

1. Elevators shall be designed with provisions for thermal expansion and contraction of complete elevator assemblies.

B. Operational Requirements

1. Hours of operation shall be considered as twenty-four (24) hours per day, seven (7) days per week.
2. Elevator components shall be designed based on the following applied duty cycle during operation
   a. Three (3) Hours with 100% Rated Load
   b. Six (6) Hours with 50% Rated Load
   c. Fifteen (15) Hours with 25% Rated Load
3. Maximum dwell time per landing in these calculations shall be no more than 10 seconds.

1.14 ENVIRONMENTAL REQUIREMENTS

A. Elevators shall be designed to operate while exposed to the natural elements of weather, including sunlight, rain, slush, snow and ice; all conditions of relative humidity while exposed to salt, de-icing chemicals, airborne dust, and debris, and corrosive elements; and in a dry bulb temperature range of minus ten (10) to plus one hundred and five (+105) degrees Fahrenheit.

B. Sound Level: Elevators shall be designed to operate at or below a sixty-five (65) decibels sound level, measured five (5) feet above the elevator cab floor at any location, with the elevator operating normally, either free running or under load. For multiple elevator installations, the noise measurements shall be made with only one (1) elevator unit in operation, but with the entire installation complete and in operating condition. An ambient level not to exceed forty-nine (49) decibels shall be maintained prior to units being turned on.

C. Seismic Zone Requirements: The elevator shall be designed to comply with seismic zone 2 requirements of ASME A17.1-2004 and A17.1S-200 regardless of edition of ASME A17.1 approved for this project. The sole exception to this requirement is where the MBTA has designed the structure for a more stringent seismic requirement.

D. Bearings: All fixed machine and motor bearing housings shall be provided with a drilled, tapped and spot faced area in the vertical and axial axis to accommodate a transducer that a Fast Fourier Transform (FFT) analyzer requires. Permanently mount transducers on the drive bearings or where recommended by the machine OEM and run the wires into the controller to a panel with BNC connectors on the ends to accommodate the FFT analyzer.

   1. Motor limit: rigid mount: .15 ips flex mount: .2 ips.

   2. Bearings shall be rated for an AFBMA L10 life as specified, under a fluctuating bearing load. All bearings shall have basic dynamic load ratings.

E. Fasteners:

   1. Fasteners shall be compatible with materials being fastened

   2. Fasteners shall be furnished with self locking nuts or retaining rings (spring washers, toothed disks).

   3. Fasteners shall be equal to or of greater corrosion resistance than the most corrosion resistant metals being fastened.

F. Ride Quality:

   1. All elevators shall have a maximum decibel reading of 70 Dba with the doors closed during a run in the up direction, measured 5 feet above the floor in the center of the cab.

   2. All elevators shall have a maximum vibration of 30 milli-g's in the X, Y and Z axis measured with an A95 filter.

1.15 COORDINATION REQUIREMENTS

A. Alterations: Contractor shall coordinate any alterations required to accommodate elevators with the MBTA.

B. Floor finish in cab: Contractor shall coordinate with other appropriate contractors and/or trades.

C. Electrical: The Contractor shall coordinate all trades regarding the installation of CCTV, communications, smoke detectors, power and cab lighting requirements.

D. Pit Drainage: Provide a means to prevent water from accumulating in the pit for outdoor elevators and indoor elevators subject to ground water or station wash downs.

E. Rigging Plan: Installer shall supply a detailed rigging plan that is approved by the MBTA. Rigging plans to include, but not limited to, path of entry/egress, imposed loading on floor surfaces and structures, product data of devices to be utilized in the rigging process with reference dimensions and lifting capacities. Rigging plans to be signed and sealed by a professional engineer registered in the State of Massachusetts.

F. Safety Training: Installer shall attend appropriate safety training programs provided by the MBTA at no extra cost.

G. As-Built Drawings: Contractor is responsible to provide revised Contract Drawings to reflect the actual as built condition including all structural, architectural, electrical, mechanical and plumbing connections to the elevators.

H. Lock Cylinders:

1. All locks and keys shall be as per MBTA's current standard lock requirements and or Engineer approval.
2. Contractor shall verify with the Engineer that the requirements for hardware have not been amended or superseded.
3. Contractor shall provide the Engineer with length, finish, and camming requirements of each cylinder required

I. Methodology: The contractor shall meet with the MBTA and provide a written method of installation for approval.

J. Installer is required to coordinate and absorb all costs and efforts to secure required variances for the elevator installations applicable.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. Subject to compliance with the requirements of this Section, provide machine room-less elevators of one of the following manufacturers:

1. Global Tardif- Z3 Model
2. Kone Inc.- MonoSpace Model
3. Schindler Elevator Corporation- 400 A Model
4. Approved equal.

B. Subject to compliance with the requirements of this Section, provide elevator cabs as specified.

2.2 MATERIAL

A. Except where product conformance to specific standards is indicated on the Contract Drawings and in ASME/ANSI A17.1, OEM's standard materials and equipment may be used in elevator construction, subject to approval. Materials cited below are intended to establish the standard of quality for comparable materials used by the manufacturer.

B. Structural Shapes, Plates, Sheets, and Tubing: ASTM A36 Steel.

C. Sheet Steel: ASNI/ASTM A446, Grade B.

D. Stainless Steel: ASTM A167, Type 316L

1. Stainless steel with embossed texture to be rolled into exposed surface. Location as noted herein.
2. Type 316L, #4 finish. Located as noted herein.

E. Aluminum: ASTM B211 or ASTM B221, Alloy 6061, T6.

F. Transparent Glazing Panels: 9/16 inch (14 mm) minimum laminated safety glass conforming to the requirements of ANSI Z97.1 and 16CFR Part 1201

G. Flooring: Provide finish flooring as specified herein.

2.3 SPECIAL FEATURES

A. General

1. Elevator shall be of size, arrangement, capacity and shall comply with design criteria specified in this Section and as shown on the Contract Drawings, and in accordance with the requirements of the ANSI/ASME A17.1-2004 and A17.1 S-2005 with Addenda Safety Code for Elevators and Escalators, hereinafter in this Section the "Code".
2. Provide all material and equipment necessary for the complete execution of all elevator work as specified in this Section and as shown on the Contract Drawings.
3. Provide hoistway guards for protecting hoistway during construction. Hoistway protection shall include high solid panels surrounding each hoistway opening at each floor.
4. All electric equipment, conduit, fittings and wiring shall conform to the requirements of ANSI/NFPA No. 70 National Electric Code.
5. Provide concrete inserts and other similar anchoring devices for the installation of guide rails, machinery and other elevator components. Epoxy ceiling anchors or epoxy side wall anchor are not permitted.
6. Clearance around equipment located in each elevator control room and machine area shall comply with the applicable provisions of ANSI/NFPA No. 70 National Electrical Code.
7. Each elevator system is to be provided with a hands free wireless maintenance communication system that provides for communication from within each elevator car enclosure, car top and control room.
8. Provide special control and notification instrumentation required by code officials for low overhead conditions that are not code compliant and require variances.

2.4 SUMMARY OF FEATURES

A South Acton Station: Elevator Quantity: 2

1. Elevator Use: Passenger
2. Contract Load, in pounds: [Insert Capacity]
3. Contract Speed, in FPM 200 (with full load)
4. Travel Distance: [Insert Travel]
5. Car Size: per contract drawings
6. Serves: [Insert Service Levels]
7. Number of Stops: 1
8. Number of Openings: [Insert Openings]
9. Operation: Selective/Collective
10. Machine Location: Overhead within Hoistway
11. Controller Location Upper Mezzanine Level

12. Machine Type: AC gearless machine room-less
13. Motor Horse Power: [Insert Motor HP]
14. Power Supply: 480V, 60Hz, 3 Phase
15. Lighting/ Signal Power Supply: 120V, 60Hz, 20A
16. Ancillary/Auxiliary Power Supply: 120V, 60Hz, Amperage
17. Car/Hoistway Door Size: per contract drawings
18. Car/Hoistway Door Type: per contract drawings
19. Car/Hoistway Door Operation: Power High-speed, heavy duty
    Minimum opening speed 3.0 FPS
    Minimum closing speed 5.0 FPS
20. Hoistway Entrance: New, as specified.
21. Cab Enclosure: New, as specified.
22. Cab Flooring: Poured Epoxy
23. Door-Reversal Device: Non Contact door reversal device
24. Car Operating Panel: Type 316L stainless Steel #4 finish with vandal resistant features
25. Car Position Indicator Type 316L stainless Steel #4 finish with vandal resistant features
26. Car Direction Indicator Type 316L stainless Steel #4 finish with vandal resistant Features
27. Hall Call Stations: Single riser
    Type 316L stainless steel #4 finish with vandal resistant buttons
28. Communication System: "Hands-Free"
29. Provide keyed switch in hall pushbutton station as directed to shut down elevator. Allen-Bradley 800 F Series 2MM Key #455.
30. Maintenance Term: One (1) year

2.5 DOOR OPERATOR EQUIPMENT

A. Provide GAL's MOVFRW-HSL door operator with encoderless VVVF drive. Closed loop door operator designed to operate car and hoistway doors simultaneously at the speed specified. Door shall open automatically when car stops at landing to discharge passengers or to answer valid calls and close automatically after predetermined time interval has elapsed. The doors shall be capable of smooth and quiet operation without slam or shock. Door operator to have the following features:

1. 1/2 hp motor and heavy duty sprocket, chain, belt, and sheaves
2. Closed loop regulated speed performance
3. Hand-held keypad programming
4. Adjustments can be stored in the keypad and downloaded to another operator
5. Adjustable door obstruction reversal

6. Optical cams with LED indicators
7. Test switches for open, close, nudging and speed zone set up
8. Universal inputs for open, close, and nudging
9. Reversing switch to back up the door reversal device.
10. Cab Door Interlock. The doors on cab doors shall be equipped with approved cab door interlocks of the cab unit system type tested as required by the Code.
    a. Interlock shall prevent operation of the car away from a landing until doors are locked in the closed position. Interlock shall prevent doors from opening at any position within the hoistway and or landing from the cab side unless car is at rest at that landing, or is in the leveling zone and stopping at that landing
    b. Cab door unlocking devices shall conform to the requirements of the Code and shall be provided to permit authorized persons to gain access to hoistway when car is away from landing
    c. Provide an electric contact mounted on the car that will prevent the car from moving away from landing unless car doors are closed.

B. Door Protection: Electronic Entrance Detector Screen: Provide TriTronics electronic door detector device, which projects an infrared curtain of light guarding the door opening. Arrange to reopen doors if one beam of the curtain is penetrated. Unit shall have transmitters and receivers spaced at a minimum distance to provide the maximum amount of protection within the height of the doorway. Systems, which have the availability to turn Off or On individual zones within the curtain, will not be allowed.

2.6 HOISTWAY EQUIPMENT

A. Guide Rails:
1. Guides shall be steel T-section rails. Rail surfaces shall be machined smooth to insure proper operation of guides. Rail ends shall be accurately machined with tongue and matching groove centrally located on web. Non wearing rail surfaces are to be painted at the completion of the elevator in color selected by the Architect.
2. Guides shall be joined and installed in accordance with Section 2.23 of the Code.
3. Guide rails are not to be in view from within the elevator cab.

B. Car Buffers: Spring type with blocking and support.

C. Counterweight Buffers: Spring type with blocking and support.

D. Roller Guides: Roller guides shall be mounted on top and bottom of the car and counterweight frames to engage the guide rails.

E. Suspension Means: If steel core ropes are supplied, a means to provide constant lubrication shall be provided. An alarm indicator shall be provided when the oil reservoir is at 25% of capacity.

F. Machine: AC gearless machine, with permanent magnet synchronous motor, direct current electro-mechanical disc brakes and integral traction drive sheave. Machine to be mounted to the car guide rail or support beam mounted at the top of the hoistway

G. Stop Switch: An enclosed stop switch, mounted in the pit of each elevator in accordance with Rule 2.2.6 of the Code, shall prevent operation of elevator when switch is activated. Switch shall be of the type described in Rule 2.2. of the Code.

H. Emergency Auxiliary Stop Switch: An enclosed stop switch, mounted in the overhead machine area and/or on the machine of each elevator in accordance with Rule 2.7 of the Code, shall prevent operation of elevator when switch is activated. Switch shall be of the type described in Rule 2.7 of the Code.

I. Dead End Hitch Assemblies: Provide dead end hitch assemblies in accordance with OEM's loading requirements.

J. Counterweight:

1. Counterweights shall consist of a steel frame welded or bolted together and necessary steel weight sections. These weight sections shall be held securely in place within the frame. A minimum of two (2)-tie rods shall pass through the holes in all weight sections. Submit paint finish of counterweights for approval. Paint color selection to be determined by the Architect.

a. A required counterweight screen where no compensation is used.

b. The bottom of the counterweight shall have a buffer striking plate and means to attach knock-off blocks during rope stretch.

c. Idler Sheave: To be located directly above the counterweight frame and integral with counterweight frame. The sheave material shall be accurately machined of semi-steel of hardness BHN 220-250 or as per manufacturer's requirements.

d. Roller guides shall be mounted on top and bottom of the counterweight frames to engage the guide rails. Counterweight guides shall be of the roller type; each guide shall consist of a set of three (3) large diameter polyurethane rollers equipped with sealed preloaded ball bearings. Each roller shall be supported by a pivoted rocker arm that shall automatically adjust itself to guide rail misalignment and prevent excessive lateral car movement.

K. Governor: Friction type over-speed governor rated for the duty of the elevator specified and to operate the car safety. The finish of pit tension sheave shall be factory paint.

1. Locate the governor where the car or the counterweight in case of over travel cannot strike it, and where there is adequate space for full movement of governor parts

2. An electrical governor overspend protective switch that, where operated, shall remove power from the driving machine motor and brake before or at the time of application of the safety.

3. Seal and tag the governor with the running speed, tripping speed, and date last tested as required by Code.

L. Tension Sheave: Provide tension sheave in accordance with OEM's governor and car safety loading requirements.

M. Terminal Limits: Limit switches shall slowdown and stop the car at the terminals if the primary automatic stopping system fails.

N. Life Safety Provisions: Life safety hooks and/or other life safety devices for fall protection to be in accordance with OSHA standards/guidelines. Life safety hook and/or other life safety devices locations to be coordinated and installed by the Installer.

2.7 MACHINE COMPONENTS

A. Motor:

1. Bearings shall be rated with an AFBMA L10 life of 65,000 hours

2. The motors shall be of the alternating current reversible asynchronous or synchronous type of a design adapted to the severe requirements of elevator service. Motor shall be capable of

developing the torque required to meet or exceed an acceleration rate of 2 ftlsec' for the elevator car.

3. A means to protect the windings and bearings from airborne dust shall be provided

4. Insulation of all windings shall be impregnated and baked to prevent absorption of moisture and oil. The insulation resistance between motor frame and windings shall not be less than one megohm. The motor windings shall stand a dielectric test of twice the normal voltage plus 1000 RMS volts of 60 Hertz, alternating current for one minute.

5. Motor leads in the conduit box shall have the same insulation class as the windings. Motor lead wire shall be rated 125 C and shall be sized for 105 C at the motor nameplate amperes at 1.0 Power Factor per Electrical Apparatus Service Association (EASA) recommendations. Leads are to be numbered for clockwise rotation when facing opposite the shaft end.

6. The motor shall be designed to stand the severe loads encountered in elevator service and the windings shall have a minimum insulation temperature rating two ratings higher than the actual temperature rise of the motor, with a minimum rating of NEMA class F.

7. The motor shall be designed to the ASME A17.1 rated load requirements.

B. Brake:

1. The brake(s) shall be of the self adjusting fail-safe (spring applied and electrically released) type provided with an external manual brake release and designed to meet the service factor demand of its intended use.

C. Gearless Machine:

1. Sheave: The sheave material shall be accurately machined of semi steel of hardness BHN 220-250.

2. Antivibrational Mounts: For machines that are support beam mounted, an antivibrational mounting pad is to be provided.

2.8 CONTROLLER COMPONENTS

A. Motion Control Engineering controller that supports DF1 communication over Ethernet ITCP/IP shall be designed to accomplish the type of elevator operation as indicated herein. Controller shall govern starting, stopping and direction of travel of the elevator. The controller shall utilize solid state start control.

B. Controller shall protect the motor against current overload, phase reversal, and phase failure. A reverse phase relay shall be provided on the controller. Controller shall automatically open the power supply, and bring the car to rest if any of the safety devices fail to operate or if the power fails.

C. Selective Collective Operation: As defined by ASME A17.1 and shall be the pressure upon one or more car buttons shall send the car to the designated landings in the order in which the landings are reached by the car, irrespective of the sequence in which the buttons are pressed, provided the hoistway door interlock and car door switch circuits are completed. During this operation, the car shall also answer calls from the landings, which are in the prevailing direction of travel. Each landing call shall be canceled when answered.

1. Pressure upon a hall button at a floor above the car location shall cause the car to start up and answer any up calls as they are reached by the car irrespective of the sequence the buttons have been pressed. The car shall not stop at floors where down buttons only had been pressed. If not further car or up hall calls are registered, the car shall reverse its direction preference to responds to car calls or down hall calls.

2. The car shall start down to answer calls below the car and shall not stop where only up calls are registered. When traveling up, the car shall reverse at the highest call and proceed to answer calls below it. When traveling down, the car shall reverse at the lowest call and answer calls above it.

3. Should both an up and a down call be registered at an intermediate landing, only the call responding to the direction in which the car is traveling shall be canceled upon the stopping of the car at the landing.

D. Controller shall be provided with starting switches of adequate size, together with all relays and switches to accomplish the type of elevator operation indicated herein. Switches that operate power circuits shall be designed t prevent sticking due to fusing. Overload relay shall be of the manual reset type of suitable size for the motor furnished.

E. All controller components shall be neatly mounted and wired in a vented NEMA 4X stainless steel enclosure. All terminals and wires shall have identification markings. Steel enclosure to be supplied with a 6" high base to prevent potential water infiltration.

F. Provide a separate battery powered unit that senses loss of power. Two (2) Batteries shall be 12 volt minimum, sealed nickel cadmium or gel cell construction. When loss of power occurs, elevator shall ascend or descend to nearest landing and open doors automatically. After a predetermined time, the doors shall close and the elevator shall remain inoperative until normal power is restored. The door open and alarm button shall operate under battery power. Reduced speed for evacuation on battery operation is permitted.

G. The PLC shall communicate directly with the Lift-Net Monitoring System.

1. General: Provide an interactive system to monitor and manage the elevator equipment ("units"), hereinafter called "system". Data collection, data storage and real-time monitoring portion of the system shall be based on Microsoft Windows and be able to run on Windows 2000 Pro, XP Pro, or later operating systems. Provide the following features:

a. Network based, capable of interfacing with control systems via either serial data link or hardwired interface connections.

b. Operate on any TCP/IP based network system including but not limited to an Ethernet, Lift-Net, etc.

c. Expansion capability to add unlimited number of monitoring terminals on the network.

d. Monitoring terminals shall operate "peer to peer" or with a single client server. Failure of a single network device shall not affect the operation of the remainder of the system.

e. Complete backup of system data shall be accomplished at any single terminal/server location.

f. Display multiple banks, including multiple buildings, on a single monitoring terminal screen.

2. Monitoring Display: The system shall be capable of simultaneous monitoring of at least five hundred units on a single monitoring station utilizing a graphical representation of a plan view of the facility. Each elevator shown on the plan view shall be individually displayed and shall be visible on the monitoring system display terminal without the need to scroll. Each individual unit, when operating "normally," shall be displayed in green. In the event of a malfunction of any individual unit, the unit shall be displayed by a red blinking light on the monitoring system display. Units which are intentionally placed out of service shall be shown as yellow in the display mode. When malfunctioning units, or units intentionally placed out of service, are returned to normal operation the graphical representation for that unit(s) shall automatically return to green. The user shall have the ability to display additional information, such as the

cause of fault/alarm, for all units by selecting the unit with a "mouse click" from the plan view of the facility. All monitored units shall be visible from any monitoring terminal on the network. Entry into the network shall be multi-level password protected.

3. System Capabilities:

   a. The system shall be capable of real time display of all monitored status points on all monitored equipment. Fault and event notification screens and audible alarms shall be immediately displayed on selected monitoring stations. Different fault and event tables shall be defined on a per-bank basis. The system shall collect and store all status, fault and event information for later reporting and analysis. The system shall provide statistical analysis of hall call response times, traffic patterns, fault conditions, service logs and security usage in graphical and tabular format.

   b. The system shall maintain a record of every status point change occurring on the monitored equipment, and provide the ability to replay these events in a simulation at a later time in real time, slow speed, single step, reverse or fast forward. This information shall be retained for a period of at least twenty-six weeks and a mechanism shall be provided whereby this information may be archived.

   c. The system shall store traffic fault and statistical data for a period of at least three (3) years. The system shall log error type, car number, floor position and major system status points whenever a fault or logged event occurs.

   d. The system shall provide interactive control of certain features provided in the elevator control system. These features may be revised as the requirements of the building change. Some of these interactive controls may include, but are not limited to, security floor lockouts, entering car and hall calls, Firefighters' service, lobby recall, VIP service, Up/Down peak service, etc.

   e. In the case of a power failure the system shall be capable of connecting to emergency power back-up unit. The loss of power shall not affect any stored data. The system shall have the capability to detect the loss (disconnect) of any individual unit from the monitoring system by periodically polling all units to ensure that normal communications between the unit(s) and the terminals/server are maintained.

   f. The system will automatically re-boot the program and continue to operate after a power loss or other system malfunction.

4. Monitoring Equipment: The monitoring equipment shall have these minimum characteristics:

   a. Monitoring Station Hardware: Provide Two Monitoring Stations.

      1. Central processing unit - IBM compatible microcomputer - desk top or mini-tower (multiple machine rooms or lobby displays)

      2. Type - Pentium or most current high-performance processor

      3. Speed - most current high-performance

      4. Internal hard drive - adequate storage for three years data for entire system

      5. Modem - most current high-performance

      6. Display monitor (19" - 20" LCD flat panel) - color, capable of simultaneous display of all monitored units

      7. Printer - current HP Color Desk Jet Series

      8. Keyboard - MS Windows compatible

9. Mouse - MS Windows compatible

10. Power requirements - 90 - 230 Volts AC 50 - 60Hz @ 8A

b. Monitoring Station Operating System Software

a. MS Windows 2000 Pro, XP Pro, or later

b. MS Windows 2000 Server, or later

5. Network requirements

a. Maximum local network rated distance (2-20 gauge shielded TP): > 10 miles

b. Maximum number of nodes (combined PC, inputs/outputs): 500

c. Maximum I/O points per node (input or output): 2040

d. Access time to status bit change (typical 6 car bank) <25ms

e. Must be capable of operating on RS485, RS422, Ethernet, Token Ring, Arc-net, Lift-Net, Fiber-Optic and mixed WAN TCPIP Networks

6. Monitoring Requirements: The system shall display and record the following information for each monitored unit. Serial data links may include many more points. Items listed below are minimum requirements.

a. Elevators:

1. Group status:

a. Group operational mode

b. All units to be monitored on the same screen in a graphical format

c. In/out of service

d. Standby power

e. Supervisory failure

f. Location and direction of hall calls

2. Individual car status - expandable menus:

a. Direction of travel

b. Independent service

c. Inspection service

d. Firefighters' service

e. Hospital Code Blue service

f. Position of elevator

g. Door status (open, opening, closing, closed)

h. Door dwell time

i. Load by-pass

j. Standby power

k. Power on/off

l. Door detector

m. Safety circuit

n. Door zone

o. Stop switch

p. Alarm button

q. Registered car Calls

r. Out of level

s. Machine room temperature exceeds 95 degrees

t. Stop Counter (Number of Starts)

u. Car speed

v. Door open times

w. Door close time

x. Start to stop motion time

y. Emergency 2-way communication device

z. Air conditioner/heater

3. Keyboard, Mouse and time clock control capabilities:

a. Floor lockouts (car or hall)

b. Lobby recall

c. VIP service

d. Firefighters' service

e. Hospital Code Blue service

f. Up/Down Peak

4. Faults monitored with visual and audible alarm, triggered by combinations of any of the above status points:

a. Safety circuit

b. Alarm bell

c. Stop switch

d. Emergency 2-way communication device

e. Door reversal device

f. At least six (6) user selectable faults or events (i.e. water in pit, high machine room/cab temperature)

7. Reporting Requirements: System shall provide reports in color graphical format both on-screen and in printed form capability to conveniently switch from one report type to another and from one bank to another using minimal mouse clicks and key strokes. Reports shall be displayed after minimal waiting time. Data for all reports shall be continuously recorded and stored. Reports shall be displayed by simply selecting a date and time range, bank of equipment and report type. Date and time range selections shall carry forward from one report selection to the next. Reporting functions shall be sub-divided into the following categories:

a. Traffic Reports (elevators):

1. Number of hall calls per floor (hall call distribution on a per floor basis)
2. Number of hall calls per hour (24 hour time-line)
3. Hall call waiting times per floor (hall call waiting time distribution on a per floor basis)
4. Hall call waiting times per hour (24 hour time-line)
5. Distributed hall call response graph (24 hour time-line)
6. Detailed hall call response graph (% calls / n seconds)
7. Longest wait times including floor #, wait time, date, time and direction

b. Fault Reports (elevators):

1. Ten most recent faults (most recent faults listed per bank)
2. Fault log - displays the entire fault log for a given time period
3. Faults per car (fault distribution on a per car basis)
4. Faults per floor (fault distribution on a per floor basis)
5. Faults per day/week/month (fault distribution on a per unit or group basis)

c. Car Use Statistics (elevators):

1. Car use by hour (24 hour time-line of car calls, car starts, door cycles, delayed car, load by pass)
2. Car use statistics (same as above, shown for an entire bank)

d. Group Service Log (elevators):

1. Cars in service (24 hour time-line with text log of group availability of each car)
2. Group functions (24 hour time-line with text log of actuation of group functions - Up peak, Down peak, Fire

8. Interface to Third Party Building Management Systems: The elevator monitoring system shall be capable of interfacing and exchanging data with a variety of third party building management systems such as Siemens, Landis & Staefa, Johnson Controls, SCADA, and others. Information shall be exchanged by Modbus protocol, open protocol or other suitable methods as required.

9. Interactive Features: The control system shall be capable where desired of operating interactive control features provided in the elevator control system. These features may be revised as the requirements of the building change. Some of these interactive controls may include but are not limited to: security floor lockouts, entering car and hall calls, Firefighters' return service, lobby recall, VIP service, UP/Down peak or hospital Code Blue service. Local codes may affect the availability or operation of these features.

a. Security Access Features: The monitoring system shall be capable of providing security enable/disable of all hall and car calls through on-screen menus at a minimum. The monitoring system shall also be capable of interfacing directly with card readers and security keypads in stand-alone mode, and indirectly through a serial interface with a third party security system. When in stand-alone mode, the monitoring system shall maintain a database of elevator users and security pass codes. When on secure mode the use of each elevator will be recorded in a file together with the time, authorized pass code and destination for each call.

b. Elevator Control Features:

1. Each elevator shall be capable of being controlled through the monitoring system. All control points shall be capable of seven-day twenty-four hour time clock automatic operation or manual operation from the mouse and keyboard. The control points shall include, but not be limited to, the following (where allowed by local codes)

    1. Lobby recall
    2. Car call security lockout
    3. Hall call security lockout
    4. Firefighters' service
    5. Independent service
    6. VIP Service
    7. Hospital Code Blue service
    8. Standby power to selected car

c. Paging Feature: The monitoring system shall be capable of paging a service technician or other personnel based on predefined parameters of elevator faults or conditions. The paging system shall provide the ability to page multiple numbers determined by the type of event triggering the notification and shall be able to page different numbers based on preset times of day (i.e. different shifts). The system shall be capable of sending text messages to full text pagers in addition to supporting standard DTMF pagers.

d. Remote Access Feature: The monitoring system shall be capable of allowing approved individuals under multi-level password control, to access all system features via the local area network, internet, or via modem over the public telephone network to review the performance of the equipment or to evaluate a fault condition. The remote access feature shall be integrated into the monitoring system and shall not use third party "remote control" software products.

e. Data Transmission to Central Support Location: The system shall be capable where desired of transmitting fault, car usage and other data to a remote service desk or other office location for further processing, technician dispatch or other purposes. The data may be transmitted via the local area network, internet, or via modem over the public telephone network.

H. Dielectric Matting: Dielectric rubber matting to be supplied on floor in front of controller to prevent accidental shock.

2.9 HOISTWAY ENTRANCES

A. General:

1. Hoistway entrances shall be of the horizontal sliding type, with operation and number of panels as indicated on the Contract Drawings.
2. All materials and finished surfaces exposed to public view shall be stainless steel with embossed finish and glass panels as indicated on Contract drawings. Glass panels to be completely flush with door assembly.

B. Hoistway Frames and Doors:

1. Entrance frames shall be of welded and mitered construction for complete one-piece unit assembly. All frames shall be sound deadened and securely fastened to fixing angles mounted in

the hoistway and shall be Rimex #5 S-M of Type 316L stainless steel. The landing sills shall be extruded stainless steel with a mill finish.

2. Entrance frames shall be provided with an extended sill floor plate the full width and depth of each entrance frame assembly. The extended sill floor plates shall be extruded stainless steel with a mill finish.

3. Hoistway entrances shall be of the horizontal sliding type, with operation and number of panels as indicated on the Contract Drawings.

4. Hoistway doors are to be stainless steel with a Rimex #5 S-M finish reinforced and provided with keyways as required for operating mechanisms and door hangers. Provide glass panels that are completely flush with door, as indicated. Each door panel shall have Z style/shaped stainless steel bottom guides that run in landing sill slots. Guides are to be replaceable without removing door panels.

5. Provide die cast jamb markings (2 per entrance) mounted at 5'-0".

6. Hoistway door hangers and door operator shall be as specified herein.

C. Struts and Closer Support Angles: Hoistway entrances adjacent to non-load bearing walls (gypsum dry wall, gypsum block, etc.) shall have hanger housing and door closers supported by steel angles of adequate size. Angles shall be continuous between sill and building beams above and shall be bolted to the hanger support. For load bearing walls (masonry, concrete block), submit for Engineer's approval Shop Drawings of the method to be used to support hanger housing and door closers on the wall.

D. Landing Sills: Landing sills shall conform to Rule 2.11 of the Code and shall be extruded stainless steel with a mill finish supplied with grooves and trash slots for door guides and machine planed for minimum clearance. Mount sills on combination of concrete/grout and steel supports anchored to floor construction.

E. Hanger Supports and Cover Plates: Hanger supports shall be Type 316L 3/16 inch thick stainless steel bolted to strut angles and closer support angles. Hanger cover plates shall be of type 316L nominal 0.078 inch thick stainless minimum and shall extend, as indicated in the contact drawings. Covers shall be made in sections for convenient access when servicing hangers. Hanger sections above door openings shall be removable from within elevator car.

F. Dust Cover: Dust cover shall be Type 316L nominal 0.078 thick stainless steel with a number 4 finish, reinforced as necessary to ensure a flat even surface throughout. Dust cover shall extend at least the full width of door opening on each side and fastened to hanger housings. Dust cover shall extend above entrance opening as indicated on Contract drawings.

G. Interlocks and Contacts:

1. The doors at each hoistway entrance shall be equipped with approved hoistway door interlocks of the hoistway unit system type tested as required by the Code.

2. Interlock shall prevent operation of the car away from a landing until doors are locked in the closed position. Interlock shall prevent doors from opening at any landing from the corridor side unless car is at res at that landing, or is in the leveling zone and stopping at that landing.

3. Hoistway door unlocking devices shall conform to the requirements of the Code and shall be provided to permit authorized persons to gain access to hoistway when car is away from landing. Stainless steel ferrules to be supplied for all hoistway unlocking device keyholes to protect elevator hoistway doors.

4. Provide an electric contact mounted on the car that will prevent the car from moving away from landing unless car doors are closed.

H. Sight Guards: Remix # 5 S-M stainless steel to match hoistway entrance finish.

I. Hoistway Sill and Extended Sill Floor Plate Heat Trace/ Heaters: Provide heat trace/ heaters at each hoistway entrance to prevent the accumulation o snow, ice and water at each hoistway entrance. Heaters shall be manufactured by Electro Plastics Inc. (www.warmfloor.com) Model # VEP-3070W-24V and or approved equal. Heaters Hydraulic oil cooler shall be provided with the following:

1. Commercial grade PVC coated polyester tarpaulin.
2. Thermostatic Control. Control to be mounted next to adjacent wall closest to hoistway and in proximity to elevator controller.
3. Moisture sensor.
4. Electrical box for direct wiring to 115VAC, 20 Amp separate circuit

2.10 CAB ENCLOSURE COMPONENTS

A. Elevator Car:

1. General:
   a. Elevator car and car components shall meet the applicable requirements of the Code. Car control station and position indicator shall be as specified herein.
   b. Entire car assembly, including car frame and platform, shall be free from warps, buckles, and squeaks and rattles. Joints shall be lightproof.
2. Car Frame and Platform:
   a. Car frame and platform shall be welded galvanized steel units designed and fabricated in accordance with applicable requirements herein and Rule 2.14 of the Code.
   b. Protect car platform with fire retardant material. The platform shall be recessed as required to accept floor finish.
   c. Sub floor material to be nominal %" stainless steel to prevent water infiltration between finished floor, cab and platform base.
   d. Floor covering for platform: Poured Epoxy floor system by Crown Polymers or approved equal. Color selection and samples to be submitted to MBTA for approval.
   e. Idler Sheaves: To be located directly below the car platform and integral with platform frame. The sheave material shall be accurately machined of semi-steel of hardness BHN 220-250 or per OEM's requirements
3. Elevator Car Guides: Car guides shall be of the roller type; each guide shall consist of a set of three (3) large diameter polyurethane rollers equipped with sealed preloaded ball bearings. Each roller shall be supported by a pivoted rocker arm that shall automatically adjust itself to guide rail misalignment and prevent excessive lateral car movement.
4. Car Enclosures:
   a. Car Top: Car top shall be of stretcher leveled, cabinet grade, and nominal 0.109 thick furniture sheet steel, reinforced to support 300 pounds on anyone square foot area. An emergency exit shall be installed in the car top in conformance with the Code. Interior surface of car top shall be painted reflective white. Exterior surface of car top shall be painted black.
   b. Size and detail to withstand design stresses and provide for attachment and support of cladding, housing, ceiling, glass panels, and appurtenances. Paint all members after fabrication. Exterior of car glazing shall be easily accessible for cleaning.

c. Suspended Ceiling:

1) ¾" nominal overall thickness. Ceiling to be constructed by bending and forming individual ceiling sections which are to be bolted together. Additional ribbing material on non-exposed side, allowed to be added for reinforcement to panel sections and for the compensation for heavy vandal resistant type light fixtures. Material to be nominal 0.109 thick stainless steel Type 316L. Finish to be Rimex Pattern No. 5-SM and or approved equal. All edges are to be deburred and ground smooth to prevent bodily injury.

2 Lighting: Car lighting shall provide a minimum of 15-foot candles and shall of the type shown on the Contract Drawings. Car lighting shall be provided with emergency battery backup upon failure or interruption of normal car lighting. Emergency lighting unit shall provide required lighting for a minimum of four (4) hours. Battery charger shall be capable of restoring battery to full charge within sixteen (16) hours after resumption of normal power. Provide an external means for testing battery, lamps, and alarm bell. Lighting is to be Benfield Electric Luminaire Model RVP26PLEL (NYC Housing Authority Grade) total quantity of fixtures as per Contract drawings. Fixture to be supplied with stainless steel face plate and stainless steel backer box. Gasketing/weatherstripping to be supplied on interior portion of hinged portion of flange to prevent water and dust accumulation when in the closed position. Outer mounting flange to be supplied with welded nuts for vandal resistant spanner head screw mounting.

d. Interior Walls: Interior walls shall be as shown on the Contract Drawings and in accordance with the following:

1 Finish shall be Type 316L Stainless with rigidized textured surface. Finish to be Rimex Pattern No. 5-SM and or approved equal.

2 Glazing per Section 2.2.

e. Hinged front and rear returns with piano hinge, transom and entrance column are to be provided in Type 316L stainless steel. Exposed surfaces are to be finished with Rimex Pattern No. 5-SM and or approved equal

f. Car Doors: Car doors to be supplied with glazed panels as indicated on Contract drawings. Glazed panels are to be completely flush with door frames. Doors shall be of the horizontal sliding type with operator, number of door panels. Exposed surfaces are to be finished with Rimex Pattern No. 5SM and or approved equal. Doors shall protect the full width and 0.109 thick stainless steel Type 316L. Finish to be Rimex Pattern No. 5-SM and or approved equal. All edges are to be deburred and ground smooth to prevent bodily injury.

2 Lighting: Car lighting shall provide a minimum of 15-foot candles and shall of the type shown on the Contract Drawings. Car lighting shall be provided with emergency battery backup upon failure or interruption of normal car lighting. Emergency lighting unit shall provide required lighting for a minimum of four (4) hours. Battery charger shall be capable of restoring battery to full charge within sixteen (16) hours after resumption of normal power. Provide an external means for testing battery, lamps, and alarm bell. Lighting is to be Benfield Electric Luminaire

Model RVP26PLEL (NYC Housing Authority Grade) total quantity of fixtures as per Contract drawings. Fixture to be supplied with stainless steel face plate and stainless steel backer box. Gasketing/weatherstripping to be supplied on interior portion of hinged portion of flange to prevent water and dust accumulation when in

the closed position. Outer mounting flange to be supplied wit welded nuts for vandal resistant spanner head screw mounting.

g. Interior Walls: Interior walls shall be as shown on the Contract

Drawings and in accordance with the following:

1 Finish shall be Type 316L Stainless with rigidized textured surface. Finish to be Rimex Pattern No. 5-SM and or approved equal.

2 Glazing per Section 2.2.

h. Hinged front and rear returns with piano hinge, transom and entrance column are to be provided in Type 316L stainless steel. Exposed surfaces are to be finished with Rimex Pattern No. 5-SM and or approved equal

i. Car Doors: Car doors to be supplied with glazed panels as indicated on Contract drawings. Glazed panels are to be completely flush with door frames. Doors shall be of the horizontal sliding type with operator, number of door panels. Exposed surfaces are to be finished with Rimex Pattern No. 5SM and or a height of car entrance opening when in the fully closed position. Car doorframe shall be integral with front wall of cab.

5. Car Door Equipment:

a. Door Hangers: Door hangers for car and hoistway doors shall be of the two point suspension sheave type equipped with grease packed heavy duty precision ball bearings, eccentric upthrust rollers, and oiler/cleaners. Track shall be of formed cold rolled steel or cold drawn steel with rounded track surface to receive sheaves. Track shall be mounted on an eccentric stud to provide for adjustment.

b. Car/Hoistway Door Operator: Car and hoistway doors at each landing shall be opened and closed quietly and smoothly by a direct current electric operator.

c. Door Protection: Electronic Entrance Detector Screen: Provide TriTronics electronic door detector device, which projects an infrared curtain of light guarding the door opening. Arrange to reopen doors if one beam of the curtain is penetrated. Unit shall have Transmitters and Receivers spaced at a minimum distance to provide the maximum amount of protection within the height of the doorway. Systems, which have the availability to turn Off or On individual zones within the curtain, will not be allowed.

6. Appurtenances:

a. Handrails: Tubular type 316L stainless steel with #4 satin finish. Tube steel to be 1 y," diameter minimum with rolled and tapered ends and supplied with stainless steel spacers. Provide as shown on the Contract Drawings.

b. Bumper Rails: Flat stock Type 316L stainless steel with #4 satin finish. Flat stock stainless steel to be minimum 5" in height to prevent damage to cab walls. Bumper rails to have rolled and tapered ends and supplied with stainless steel spacers. Provide as shown on the Contract Drawings

7. Safety: A governor actuated mechanical safety device mounted under the car platform and securely bolted to the car sling. The car safety shall be sized for the capacity and speed noted on the Contract Drawings.

a. When tripped, the safety mechanism shall engage the rails with sufficient force to stop a fully loaded car with an average rate of retardation within the limits given by the ASME A17.1 Code for the capacity

b. Make provisions to release the car safety. In no event shall the safety be released by downward motion of the car. Raising the car to reset the safety shall be allowed

c. Include .an electrical safety plank switch that will interrupt the power to the hoist machine when the safety is set. Resetting the plank switch shall be separate from resetting the safety jaws.

d. Install a car safety marking plate of corrosion resistant metal showing the data required by the Code.

2.11 SIGNAL DEVICES AND FIXTURES

A. General: Provide signal fixtures and control devices for each elevator. Buttons and signals shall be tamper resistant of the illuminated type that light-up when activated and remain lit until call or other function has been fulfilled. All signal fixture and control device faceplates shall be of Type 316L, nominal 0.135 inch thick stainless steel with NO.4 finish, unless otherwise shown on the Contract Drawings.

B. Car Operating Station:

1. Provide one (1) main station in the front and one (1) auxiliary station at the rear return of the elevator.

2. Car operating stations shall contain Braille plates that spell out landings served adjacent to each call button. Contractor to coordinate proper landing call outs based on maximum characters as indicated on Contract drawings. Buttons for DOOR-OPEN, DOOR-CLOSE, ALARM, EMERGENCY PHONE call functions are to be supplied. Buttons are to be vandal resistant and of the positive stop type. Buttons to be Monitor Control Model #HPS1300 with rounded edges and 1 3/8" in diameter.

3. Station shall also have keyed switches for car light, cab air conditioning, cab air conditioning evaporator, heater, inspection, independent operation, as indicated on the Contract drawings.

4. Station faceplate shall be Type 316L stainless steel with #4 finish. As indicated on the Contract drawings.

5. Engrave the car operating panel with the following:

   a. No Smoking. Minimum 1 inch high lettering.

   b. In Case of Fire Do Not Use Elevator, as per 524 CMR regulations

   c. Elevator Capacity: Minimum 3/8 inch high lettering.

   d. Firefighters Operating Instructions.

   e. No Smoking Symbol

6. Provide die cast raised markings for the car buttons and car controls in compliance with the "Handicapped Requirements" of ANSI/ASME A17.1. Die cast plates are to be flush with faceplate surface, as indicated on Contract drawings.

7. Provide die cast raised markings for the elevator and station identification in compliance with the "Handicapped Requirements" of ANSI/ASME A17.1. Die cast plates are to be flush with faceplate surface, as indicated on Contract drawings

8. Emergency Communication: "Hands-free" ADA compliant telephone/intercom, VPP model T-1250E.

C. Top of Car Operating Device: Provide a top-of-car operating device in compliance with the requirements of Rules 2.26 of the Code. The device shall have control switches for UP, DOWN,

OPERATEIINSPECT and EMERGENCY STOP. The device shall also have an 110v ac outlet for extension cord and provided with a light and rigidized guard.

D. Hall Stations: Hall stations of the push-button, call acknowledging, stainless steel, tamper resistant type shall be recess mounted into the wall and or returns at all elevator landings, as indicated on Contract drawings.

1. Buttons are to be vandal resistant and of the positive stop type Buttons to be Monitor Control Model #HPS1300 with rounded edges and 1 3/8" in diameter with red jewel.
2. Highest landing shall have a single DOWN button. Lowest landing shall have a single UP button. Intermediate landings shall have UP and DOWN buttons with the Up button on top.
3. All hall stations to be supplied with Push For Help button.
4. Phase I Fire Service illuminating fire hat to be supplied.
5. Provide die cast raised markings for the hall buttons in compliance with the "Handicapped Requirements" of ANSI/ASME A17.1. Die cast plates are to be flush with faceplate surface, as indicated on Contract drawings.
6. Provide die cast raised markings for the elevator and station identification in compliance with the "Handicapped Requirements" of ANSI/ASME A17.1. Die cast plates are to be flush with faceplate surface. as indicated on Contract drawings
7. Engrave the hall station with the following:
   a. In Case of Fire Do Not Use Elevator, as per 524 CMR regulations
   b. Firefighters Operating Instructions, as indicated on Contract drawings
8. "Hands-free" ADA compliant telephone/intercom, VPP model T-1250E.
9. Additional switches for Hoistway access, Phase I Firefighters Operation and Parking feature are to be supplied. Keyswitch requirements for Phase I Firefighters Services to be in accordance with national and local code requirements. Keyswitch requirements for Hoistway access and Parking feature per MBTA's current standard lock requirements and or Engineer approval
10. Faceplate finish shall be Type 316L stainless steel #4 finish

E. Hall Lanterns:

1. Tamper resistant hall lanterns shall be equipped with illuminated UP and DOWN signal arrows, but provide single arrow where only one direction is possible. Provided units projecting from faceplate for ease of angular viewing. Match materials, finishes and mounting method with hall stations.
2. In conjunction with each hall lantern, provide an adjustable electronic chime signal to indicate that a car is arriving in response to a hall call and to indicate direction of car travel. Signal shall sound one for up direction of travel and twice for down direction.

F. Bell Alarm System: Bell alarm system for each elevator shall be properly located within building and audible outside hoistway when activated by the EMERGENCY STOP switch or the ALARM call button on each car control station.

G. Firefighters' Service System: Firefighters' service system shall be provided in compliance with national and local code requirements.

2.12 WIRING AND ELECTRICAL INSTALLATION

A. Electrical installation shall be in accordance with Division 16.

B. Conduit and Wiring:

1. Unless otherwise specified, all electrical conductors in the pits and hoistways, except traveling cable connections to the car shall be provided in rigid zinc-coated steel conduit with steel outlet boxes, except that a small amount of flexible conduit may be used where conduit is not subject to moisture or embedded in concrete. Terminal boxes and other similar items shall be of approved construction, thoroughly reinforced, and in no case less than number 12 USSG. All electrical boxes exceeding 150 cubic inches shall be supported independently of the conduits. The rigid conduit shall conform to the specifications here in before specified. All raceway shall be threaded rigid steel conduit. Flexible heavy-duty service cord, type SO, may be used between fixed car wiring and switches on car doors for door reversal devices.

2. All conduits terminating in steel cabinets, junction boxes, wireways, switch boxes, outlet boxes and similar locations shall have approved insulation bushings. If the bushings are constructed completely of insulation material, a steel locknut shall be installed under the bushing. At ends of conduits not terminating in steel cabinets or boxes, the conductors shall be protected by terminal fittings having an insulated opening for the conductors. All conduits terminating in NEMA 4X boxes shall be backed up with flat rust resistant steel plates to fit the entire area where the conduit penetrated the box.

3. Conduit fittings and connections using set screws or indentations as a means of attachment are not permitted

4. Connect motors and other components subject to movement or vibration, to the conduit systems with flexible conduit.

5. The Contractor shall furnish all materials and completely wire all parts of the electrical equipment of the elevators including electrical devices on hatch doors.

6. All solid state and electrical components located on top of the car enclosure or in the hoistway shall be installed within NEMA 4X enclosures

7. The conduits shall be of such size that the wires or cables can be readily installed and replaced, if necessary. No conduit or raceway shall be less than 3/4 inch trade size, except that for small devices such as door switches, interlocks, etc., Y, inch conduit may be used. The total overall cross sectional area of the wires contained in any conduit shall not exceed 40 percent of the internal area of the conduit.

8. Conduits shall be neatly and systematically run. All exposed conduit and boxes shall be supported by approved and substantial straps, hangers or clamps to the structural. steel, reinforced concrete, or other approved supports. Riser conduits in hoistway shall be supported at each floor level.

9. All interlock, hall button and limit switch branch wiring shall be enclosed in flexible steel conduit with covering of liquid tight Type "EF" with connectors having nylon insulated throat.

10. All screws used for terminal connections of all wiring (control room, machine area, hoistway and pit) shall be provided with "star washers" of proper size and type.

C. Conductors:

1. No joints or splices shall be permitted in wiring except at outlets. Tap connectors may be used in wireways provided they meet all UL requirements

2. All wiring shall test free from short circuits or grounds. Insulation resistance between individual external conductors and between conductors and ground shall be not less than one meg-ohm.

3. Provide all necessary conduit and wiring between all remote control rooms, machine areas and hoistway.

D. Traveling Electrical Cable

1. Shall be Type EO, rated for a maximum of 300 volts, and shall comply with the requirements of UL Standard #62 and Articles 400 and 620 of ANSI/NFPA No.

2. Travel cables shall include separate coaxial cable shielded for the communications system

4. Provide 10 percent spares, but not less than 6 spare conductors in each traveling cable

5. Provide two (2) spare CCTV wires and two (2) twisted shielded pair

6. Provide separate traveling cables for car lighting and fan control circuits.

7. Provide traveling cable for telephone in the elevator car. Cable shall extend from junction box in hoistway to telephone box in car.

8. Provide traveling cable for car work lights

9. All insulated wiring, control wiring and wiring in traveling cables shall be tag coded at their terminals in the motor room or controller location and hoistway junction box, elevator cab junction box, and push-button stations within the cab, and shall agree with the approved wiring diagrams.

E. Car and hall operating signal circuits shall not exceed 48 volts.

F. All cabinets containing motor drives, filter boxes, transformers and power reactors shall be supported on rails and isolated from the base building structure with elastomer pads having a minimum static deflection of 3/8" (Mason Type N, or equivalent). All connections to and from the cabinetry shall be flexible in order not to compromise the isolation system. Use non-rigid conduit for the final electrical connection, with all other conduit supports and clamps provided on a neoprene sponge insert.

2.13 OPERATION

A. General: Operation shall be simplex collective.

1. Simplex Collective Operation:

a. Operation shall be automatic by means of the car and landing buttons. Stops registered by the momentary actuation of the car or landing buttons shall be made in the order in which the landings are reached in each direction of travel after the buttons have been actuated. All stops shall be subject to the respective car or landing button being actuated sufficiently in advance of the arrival of the car at that landing to enable the stop to be made. The first car or landing button actuated shall establish the direction of travel for an idle car.

b. "UP" landing calls shall be answered while the car is traveling in the up direction and "DOWN" landing calls shall be answered while the car is traveling down. The car shall reverse after the uppermost or lowermost car or landing calls has been answered, and proceed to answer car calls and landing calls registered in the opposite direction of travel.

c. If the car without registered car calls arrives at a floor where both up and down hall calls are registered, it shall initially respond to the hall call in the direction that the car was traveling. If no car call or hall call is registered for further travel in that direction, the car shall close its doors and immediately reopen them in response to the hall call in the opposite direction. Direction lanterns, if provided, shall indicate the changed direction when the doors reopen.

B. Independent Service: Provide a key switch in the car operating panel which, when actuated, shall cancel previously registered car calls, disconnect the elevator from the hall buttons and allow operation from the car buttons only.

C. Non-Contact Door Reopening Device operation shall be as follows:

1. The doors shall be prevented from closing from their full open position if any obstruction comes within the zone of detection. The detection zone shall move with the doors and if a person or object enters the zone as the doors are closing, the doors shall reverse and reopen. The doors shall re-close after a minimal time interval. A passenger entering or leaving the car shall not cause the doors to stop and reverse unless the doors reach a predetermined proximity to the passenger.

2. After a stop is made, the doors shall remain open for a time interval to permit passenger transfer, after which the doors shall close automatically. This interval shall be less for a car call stop than for a hall call stop or a coincident car/hall call stop. Car Stall Protective Circuit: Provide a protective circuit which shall stop the motor and return the car to its first floor landing in the event that the car, while traveling up, does not reach its designated landing within a predetermined time interval. This circuit shall permit a normal exit from the car but prevent further operation of the elevator until the problem has been corrected.

Door Operation:

1. Door close shall be arranged to start after a minimum time, consistent with handicapped requirements, from notification that a car is answering a hall call.

2. Doors shall be arranged to remain open for a time period sufficient to meet handicapped requirements.

3. The time interval for which the elevator doors remain open when a car stops at a landing shall be independently adjustable for response to car calls and response to hall calls.

4. An approved positive interlock shall be provided for each hoistway entrance, which shall prevent operation of the elevator unless all doors for that elevator are closed and shall maintain the doors in their closed position while the elevator is away from the landing. Emergency access to the hoistway as required by governing codes shall be provided.

D. Standby Power Transfer: Upon the loss of normal power provide controls to automatically lower the elevator(s) nonstop to the lowest landing designated by the Fire Department. When arriving at the lowest landing, the elevator doors shall open automatically and remain open until regular door time has expired. The elevator shall then become deactivated.

E. Automatic Leveling: Machine room less gearless machine/motor design shall be coordinated with the control so that car shall slow down and stop automatically at the floor (within 1/4 inch) after transition from contract speed. Car level shall be maintained automatically within one-quarter inch of the landing by an anti-creep leveling device regardless of any deviation that maybe caused by the loading or unloading of the car. Landing zone detection shall indicate to the control system the position with respect to the floor level.

F. Battery Standby Power Transfer: Upon the loss of normal power provide controls to automatically lower the elevator(s) nonstop to the landing designated by the Fire Department. When arriving at the designated landing, the elevator doors shall open automatically and remain open until regular door time has expired. The elevator shall then become deactivated. The control panel for the automatic lowering device shall be located in the elevator control area. The panel shall include two (2) gel batteries, solid-state controls, charger, monitor lights and a test button. Battery to be rechargeable with a 10-year life expectancy.

G. Top-of-Car Operating Device: Operation of elevator from top-of-car device shall also be subject to applicable electrical protective devices required in Rule 2.26 of the Code.

H. Elevator Control Room:

1. A metal cabinet of not less than twenty (20) cubic feet in volume shall be provided and located in the control room area. Cabinet to be rated to hold flammable materials.
2. Cabinet shall have lockable doors and be mounted on legs or a pedestal, minimum of four (4) inches off the floor.
3. Cabinet shall be painted and marked for elevator purposes, as directed by the MBTA, and Contractor shall store small parts, supplies, tools, and other materials within.

PART 3 – EXECUTION

3.1. EXAMINATION

A. Prior to commencing with the installation of elevator equipment, examine the following and verify that no irregularities exist that would affect the quality of execution of work as specified.

1. Hoistway size and plumbness.
2. Anchor brackets.
4. Sill support.
5. Pit depth.
6. Overhead clearance.

3.2. INSTALLATION

A. Install elevator in accordance with the OEM's installation procedures and approved Shop Drawings.

B. Verify that electrical wiring installation is in accordance with the OEM's submittal and in accordance with the installation requirements of other Sections of the Specifications.

C. Erect all items square, plumb, straight and accurately fitted with tight joints and intersections.

D. Coordinate all trades to ensure that the installation of the elevators is not in conflict with the work performed of other trades.

E. Isolate non-compatible, dissimilar materials from each other by providing vibration isolation, gaskets or insulating compounds.

F. Provide protective coverings for finished surfaces.

G. Upon completion, touch up and restore damaged or defaced factory finished surfaces. Touch up any marred finishes and replace as directed by the Authority.

H. Remove protective coverings and clean exposed surfaces after completion.

I. Welding shall comply with AWS 01.1. Identify field welds with welder's identification stamp.

3.3. FIELD TESTING

A. Acceptance Testing:

1. General: After installation and before date approved for start of interim maintenance, inspect and test the elevator and related equipment to the Engineer's satisfaction that operation of every part of equipment complies with applicable requirements of ASME/ANSI A17.1 including sound level criteria specified in paragraph 1.4E herein. Elevator shall be inspected in accordance with procedures outlined ANSI/ASME A17.2.

   a. Provide test instruments, materials, other necessary facilities, and all labor required for acceptance tests specified.

2. Notification Requirements:

a. Notify the Project Manager and the Engineer a minimum of five (5) working days prior to each scheduled test.

3. Full Load Run Test: Run elevator continuously a minimum of twenty four (24) hours with full specified rated load, during which time car shall be stopped at top and bottom landings with a minimum standing period of 10 seconds at each landing.

4. Speed Test: Make tests before and after full load tests. Using a tachometer on guide rail, determine actual speed of car in both directions of travel, both with full-specified rated load and no load in car. Tolerances for determining if car speeds meet the specified requirements are as follows:

   a. Ascending Car Speed: Not more than 10 percent above or more than 10 percent below required speed.

   b. Descending Car Speed: Not more than 10 percent above or more than 10 percent below required speed.

5. Car Leveling Test: Determine accuracy of floor landing tests both before and after full load run tests. Minimum of 1/4 inch leveling must be maintained. Test accuracy of landing at all floors with full load and no load in car, in both directions of travel.

7. Electrical Tests: Ensure elevator wiring system is free of short circuits and accidental grounds. Test ground resistance of elevator structure, equipment, and raceways for continuity. Using megohm-meter, determine that insulation resistance of each circuit is more than one (1) megohm or higher as required by the cable manufacturer. Insulation resistance for motors shall be determined under actual conditions after installation.

8. Acceptance: Elevator acceptance will be based upon elevators meeting requirements of Contract Documents and upon evidence of passing specified acceptance tests and inspections. Final testing will be after elevators are connected to permanent power.

8. Test Reports: Within five (5) days after completion of a test, submit a test report stating type of test, test requirements, failures, or problems, and name of certifying Engineer and Title. Safety device failure or defective equipment shall be identified, with description of cause and corrective action taken.

9. Failures for any reasons shall be identified with causers) and corrective action taken.

10. Retest Notification Requirements:

    a. The Project Manager and Engineer shall be notified ten (10) days prior to the scheduled retest.

    b. If any equipment is found to be damaged or defective, or if the performance of the elevator does not conform to the requirements of the contract specifications or the Safety Code, no approval or acceptance of elevators shall be issued until all defects have been corrected. When the repairs and adjustments have been completed and the discrepancies corrected, the MBTA shall be notified and the elevator will be reinspected. Rejected elevators shall not be used until they have been reinspected and approved.

11. The certificate of inspection for operational use will be issued to the MBTA by the enforcing inspection agency. The certificate shall be posted in the elevator control room and in the car operating station.

B. Any deficiencies and defects discovered during the field-testing shall be corrected, repaired, replaced and retested to the satisfactory of the Engineer.

3.4. ADJUSTING AND CLEANING

A. Immediately upon the completion of the elevators, thoroughly clean each elevator including car and hoistway doors and install 3/4 inch fire retardant plywood on wood studs (2 feet -0 inches on centers) to protect all hoistway doors, frames and sills. This protection shall be maintained until the MBTA orders its removal, just prior to acceptance. At that time the Installer shall perform a complete re-cleaning including doors and cabs.

B. Remove all debris not necessary for the elevator's operation that could cause safety problems.

C. Keep areas orderly and free from debris during the progress of the Project.

D. Remove all loose materials and filings resulting from this work from hoistway surfaces, pits and control room spaces.

E. Clean control room floor of dirt, oil and grease.

3.5. MBTA COORDINATION

A. Engage OEM authorized service representative to train MBTA's maintenance personnel to operate elevators. Refer to Section 01820 "Demonstration and Training."

B. Check operation of elevators with MBTA's designated personnel present and before date of Substantial Completion. Determine that operation systems and devices are functioning properly.

C. Check operation of elevators with MBTA's personnel present not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

PART 4 MEASUREMENT AND PAYMENT

4.1. MEASUREMENT

Separate measurement and payment will not be made for the work of this section complete in place, but all costs therefore shall be included in the Contract Lump Sum Price for the work as indicated herein.

4.2. PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
1420.000	ELEVATORS	LS

END OF SECTION

SECTION 16050

BASIC MATERIALS AND METHODS FOR ELECTRICAL WORK

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies basic materials and methods for electrical work.

B. Related Work: Refer to Section 16450-Grounding, for proper installation of components identified in this section. The following items are not included in this Section and will be performed under the designated Sections:

1. Determine interfaces and coordinate electrical work with utility company or the Authority where power source is the Authority's.
2. Determine interfaces and coordinate with work completed, progressing, or to be performed under other sections of these Specifications or by other contractors. Make indicated connections to previously completed work. Where future connections to or extensions of the work are indicated, make safe and convenient provisions for such future connections and extensions.
3. Where indicated, take possession of, maintain, and operate as required any electrical plant and equipment left in place by others. Where indicated, leave temporary and interim electrical work, plant and equipment in place for maintenance and operation by others.
4. Furnish and install a 9 way – 4 inch low voltage/control/signal concrete encased ductbank system as shown in the contract drawings.
5. Furnish and install a 120/240V, single phase 60Hz secondary metering power service obtained from the supplying Power Company.
6. Furnish and install an electrical service consisting of 120/240V distribution panels, lighting contactor, controls, receptacles, and associated appurtenances as specified herein and as shown on the Contract Drawings.
7. Coordinate with the supplying Telephone Company for new telephone service for the Control Cabins (Power and Control Shelter).
8. Furnish and install grounding systems including ground rods, thermit welds, cables and connections.
9. Furnish and install exterior lighting systems.
10. Furnish and install Variable Message Sign (VMS), Closed Circuit Television (CCTV), and Public Address (PA) Systems as indicated in the Contract Drawings.
11. Work under this item shall also include furnishing and installing RGS and/or PVC conduits under platforms and other areas as shown on the Contract Drawings.
12. Disconnect/reroute/extend existing aerial signal/power cable as shown on contract drawings.

1.2 REFERENCES

A. Comply with applicable requirements of the following:

1. National Electrical Code
2. Massachusetts Electrical Code

1.3 SUBMITTALS

A. Submit shop drawings for review showing fabricated work being furnished and installed under these Specifications. Submit such drawings prior to fabrication and within ample time to prevent delays in the work.

B. Submit verified test results to the Engineer promptly upon completion of test.

C. Before installation of the wire and cable, submit the following information for each type and size of wire and cable for review:

1. Manufacturer of the wire and cable.
2. Number and size of strands composing each conductor.
3. Conductor insulation composition and thickness in mils.
4. Average overall diameter of finished wire and cable.
5. Minimum insulation resistance in megohms per 1000 feet at 20°C ambient.
6. Jacket composition (if any) and thickness in mils.
7. Total number of conductors per cable.
8. Shield material (if any) and thickness.
9. Conductor resistance and reactance in ohms per 1000 feet at 20°C ambient.
10. Conductor ampacity at 20°C ambient.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Furnish all items of the materials, design, sizes, and ratings shown on the Contract Drawings and herein specified.

B. Furnish materials and equipment bearing evidence of UL listing where UL standards exist and such product listing is available.

C. Methods of fabrication, assembly and installation are optional unless otherwise specifically indicated.

D. Provide products that are free from defects impairing performance, durability, or appearance, and of the commercial quality best suited for the purpose shown on the Contract Drawings or specified herein.

E. Steel conduit and accessories specified to be zinc coated: Hot-dipped galvanized after fabrication in accordance with ASTM A286.

F. Conform to applicable requirements of Insulation Power Cable Engineers' Association (IPCEA).

2.2 RIGID GALVANIZED STEEL CONDUIT AND ACCESSORIES

A. Conduit, couplings, elbows, bends, and nipples: ANSI C80.1 and UL 6, with each length bearing manufacturer's stamp and UL label.

B. Method used to determine the thickness of zinc coating: The Referee Test included in the appendix to ANSI C80.1.

C. Fittings and Accessories:

1. Galvanized steel or malleable iron, ANSI C80.4.
2. Provide separable watertight hub fittings with a gasket, separate nylon insulated throat and a case hardened locknut.
3. Bushings: Nylon insulated metallic and grounding type.
4. Furnish conduit straps, clamps, and clamp backs made of galvanized malleable iron.

D. PVC Coated Conduit

1. NEMA Standard No. RN1, Coating Type A-40.
2. Thread protectors installed on both ends of conduit for shipment and handling, couplings packaged separately.

E. Almost without exception, in any below grade structures, the MBTA requires the use of RGS conduit.

F. Buried conduits cannot have buried pull boxes.

2.3 LIQUID-TIGHT FLEXIBLE METALLIC CONDUIT AND FITTINGS

A. Furnish conduit consisting of a core of flexible galvanized steel with an extruded liquid-tight plastic or neoprene jacket overall. Jacket shall be moisture and oil-proof, capable of conforming to the minimum radius bends of flexible conduit without cracking.

B. Furnish conduits with a continuous copper bonding conductor spiral wound between the convolutions, as required by NEC, and as indicated.

C. Fittings: UL Standard 514, cadmium or zinc-coated.

2.4 PVC ELECTRICAL CONDUIT AND FITTINGS (ONLY FOR OUTDOOR USE)

A. Heavy wall, high impact strength, rigid PVC conforming to the requirements of EPC-40-PVC conduit of NEMA TC2 and fittings for EPC-40-PVC conduit of NEMA TC3.

B. UL listed in accordance with Article 347 of the NEC for underground and exposed use.

C. Flammability rated as self-extinguishing, and having the following minimum properties:

1. Tensile strength, ASTM D638 at 78°F: 6,000 psi.
2. Flexural strength, ASTM D790: 11,000 psi.
3. Compressive strength, ASTM D695: 8,500 psi.
4. Hardness (Durometer D), ASTM D2240: 77.
5. Water absorption, percent maximum, in 24 hours at 72°F. ASTM D570: 0.03.
6. Dielectric strength, volts per mil, ASTM D149: 1,100.
7. Thermal conductivity: 1.3 BTU per square foot per degree F per inch.

2.5 CONDUIT EXPANSION FITTINGS

A. Fabricate from material similar to the type of conduit with which they are to be used.

B. Include a factory installed packing ring, designed to prevent the entrance of moisture, and a pressure ring.

C. Also include a grounding ring or a grounding conductor for metallic expansion couplings.

2.6 MULTIPLE PIPE HANGERS (TRAPEZE TYPE)

A. Fabricate of two or more steel hanger rods, a steel horizontal member and all U-bolts, clamps, and other attachments necessary for securing hanger rods and conduits.

B. Hanger Rod: Not smaller than 3/8 inch diameter, threaded either full length or for a sufficient distance at each end to permit at least 1-1/2 inches of adjustment.

C. Horizontal Member

1. Standard structural steel shapes such as angles or channels, 1-1/2 by 1-1/2 or 1-5/8 by 1-5/8 inches, 12 gauge, cold-formed, lipped channel, and designed to accept special spring-held hardened steel nuts for securing hanger rods and other attachments.
2. Two or more channels may be welded together to form horizontal members of greater strength than single channels.
3. Galvanize after fabrication.

D. Design

1. Capable of supporting a load equal to the sum of the weights of the conduits and wires, the weight of the hanger itself, plus 200 pounds.
2. The stress at the root of the thread of the hanger rods; not more than 9,475 psi at design load.
3. Size the horizontal member such that the maximum stress will be not more than 12,650 psi at design load.

2.7 INSERTS

A. Channel Inserts. Fabricate from not less than 12 gauge steel channel having an overall size of 1-1/2 by 1-1/2 or 1-5/8 by 1-5/8 inches with continuous 7/8 inch wide slot, in lengths as indicated. Galvanize after fabrication.

B. Channel Inserts for Embedding in Concrete

1. Fabricate from channels having a solid base.
2. Weld concrete anchors to the channel during fabrication and before coating.
3. Galvanize after fabrication
4. Provide assemblies with a minimum pull-out load rating of 4,500 pounds per linear foot uniformly distributed.
5. Furnish all channel inserts for installation embedded in concrete with the channel interior completely filled with Styrofoam to prevent seepage of concrete into the channel during installation.

C. Channel Inserts for Surface Mounting

1. Fabricate from channel having 3/8 inch by 3-inch slots on 4-inch centers in the base.

2. Galvanize inserts for surface mounting on concrete surfaces or for installation in damp or wet areas.

D. Spot Inserts for Embedding in Concrete

1. Steel, galvanized after fabrication
2. Designed for a maximum loading of 800 pounds with safety factor of three.
3. Knockout openings to accommodate either square or rectangular nuts.

2.8 FIBERGLASS STRUT CHANNEL

A. NEC and ASTM D-4385

B. NEMA 4X rating (minimum).

C. Shall be of type Cooper-BLine series BFP22 or equivalent.

2.9 SURFACE METAL RACEWAYS AND FITTINGS

A. ANSI/UL 5 and the NEC.

B. NEMA 3R rating (minimum).

2.10 OUTLET, JUNCTION AND PULL BOXES

A. Conform to NEC Article 370. Electrical boxes shall conform to UL-50, "Standard for Electrical Cabinets and Boxes", and UL-514, "Standard for Electrical Outlet Boxes and Fittings".

B. Provide electrical boxes of the material, finish, type and size indicated and required for the location, kind of service, number of wires, and function. Boxes shall have mounting holes retapped for 10-24 machine screws.

C. Provide boxes complete with accessible covers designed for quick removal and suitable for the purpose for which they will be used, except that boxes in which or on which no devices or fixtures are to be installed, shall be equipped with flat or raised blank covers as required. All ceiling fixture outlet boxes shall be equipped with 3/8-inch boltless fixture studs.

D. Boxes not over 100 cubic inches in size shall be cast. Boxes over 100 cubic inches in size shall conform to the requirements for cabinets.

E. Covers: Same thickness as boxes and secured in position by means of No. 10-24 stainless steel machine screws. Arrange covers to be readily and conveniently removed.

F. Coat junction boxes inside and outside to prevent oxidation. Where outlet boxes are used as junction boxes they shall be cast aluminum and not be smaller than 4 inches square by 1-1/2 inches deep. Provide such boxes with flat blank covers.

G. Outlet Boxes: Cast aluminum, not be smaller than 4 inches square by 2-1/8 inches deep.

H. Concealed Switch Boxes: Cast aluminum, not less than 4 inches square by 1-1/2 inches deep for two devices unless otherwise indicated. Provide covers with rectangular openings of proper size and shape. Furnish and install special boxes required to suit the kind of service and location requirements, as indicated, and as may be directed by the Engineer.

I. Cast metal boxes shall be of aluminum alloy, with compatible conduit fittings.

J. Boxes for exposed switches and receptacles: Cast metal, FS and FD Types.

K. Furnish brackets, supports, hangers, fittings, bonding jumpers and all other accessories required.

L. Provide neoprene gaskets 1/8 inch thick with boxes subjected to weather, and as directed by the Engineer.

M. Grounding. Provide each box to which a lighting fixture or receptacle is to be attached with a grounding terminal.
   1. Grounding Terminal: Either a green-colored washer-in-head machine screw not smaller than No. 10-32 in a drilled and tapped hole in the back of the box, or a grounding bushing with green-colored machine screw terminal attached to one of the conduits.
   2. Provide suitable grounding terminals in motor connection boxes.
   3. Install grounding jumpers as specified in Section 16450 - GROUNDING.

N. Junction and pull boxes must be surface mounted and not buried.

2.11 WIRE AND CABLE (600 VOLT)

A. Conductors: Conform to the requirements of the NEC.

   1. Feeder and Branch Circuit Conductors: Soft-drawn copper.
   2. Control Circuits: Soft-drawn copper.
   3. Conductor Sizes: Standard American Wire gauge sizes. Conductors No. 10 and smaller, solid copper; No. 8 and larger, stranded copper.
   4. Minimum AWG sizes unless otherwise indicated:
      a. No. 12 for branch circuits.
      b. No. 14 for control wire and fixture wire
      c. No. 16 for low voltage circuit and indication wire.

B. Wire and Cable 600 volts and Below Installed Raceways: Single conductor, NEC type XHHW, conforming to requirements of NEMA WC 7, or THWN.

C. Fixture Wire: Type AF single conductor, rated for 150°C conductor temperature, 300 volts.

D. Color Coding of Conductors

   1. Color code supply cables and branch circuit conductors throughout the secondary alternating current wiring system as follows:

Conductor	240/120 Volts
Neutral	White

Ground	Green

2. Branch circuit phase conductors No. 10 and smaller and all neutral and equipment conductors: Solid color insulation or solid color coating.
3. Solid color coatings and tracers: A strongly adherent paint or dye not injurious to the insulation and which will not be obliterated by pulling into a conduit or raceway.
4. On-site coloring of ends of conductor may be permitted by the Engineer upon receipt of satisfactory evidence that the Contractor is unable to order color-coded wire and cable as specified. Provide certification from the cable manufacturer that the paint or dye proposed for field application is non-injurious to the insulation. Colored tape may be used to mark the ends of conductors in lieu of paint or dye.

E. Identification Tags

1. Provide waterproof identification tags of brass, aluminum, plastic, or pressure-sensitive moisture-resistant labels designed for fastening to cables, feeders, and power circuits in vaults, pull boxes, manholes, and switchboard rooms and at all terminations of cable or wire.
2. Stamp or print tags or labels to correspond with markings on the Contract Drawings or accepted Shop Drawings, or mark so that feeder, cable or conductor may be readily identified. Tags on conductors at switches, receptacles, motor control panels, wireways, and junction boxes shall bear the circuit number of the conductor as it appears in the circuit directory. Mark conductors in motor control panels with the terminal number.
3. If suspended type tags are provided, design tie tags with slip-free plastic cable lacing unit or design for attachment by nylon bundling straps.

F. Cable Supports and Fasteners: Design for use with channel inserts.

G. Conductor Bundling Straps

1. Formed from self-extinguishing nylon having a temperature range of minus 65°F to plus 250°F.
2. Equip each strap with a locking hub or head with a stainless steel locking barb on one end and a taper on the other end.
3. Make wire and cable ties for installation outdoors and in exposed locations of ultraviolet resistant nylon material.

H. Splice and Terminal Connectors

1. Design termination fittings for use with the cable furnished, NEMA Standard, and UL approved.
2. Termination and splice fittings for No. 10 and smaller conductors; Screw on, spring pressure-type copper connectors with nonflammable, self-extinguishing insulation of temperature rating equal to that of cable being connected. Terminals to provide a metal insulation grip on the conductor for stain relief.
3. Termination and splice fittings for No. 8 and larger conductors: Tool-applied compression connectors of material and design compatible with the conductors for which they are used.
4. Terminal connectors for conductors Size No. 4/0 and larger: Long-barrel, double compression type, and furnished with two bolting holes in the pad.

I. Insulating Material for Splices and Terminations

1. Of the type approved by the Engineer for the particular use, location and voltage, 3/4 inch nominal width.
2. Plastic electrical insulating tape for general use: Vinyl plastic with rubber-based pressure-sensitive adhesive. Pliable at temperature of minus 18°C to 105°C. When tested in accordance with ASTM D 3005, the tape shall have the following minimum properties:
   a. Thickness: 7 mils.
   b. Breaking Strength: 15 pounds per inch.
   c. Elongation: 200%.
   d. Dielectric Strength: 10,000 volts/mil
   e. Insulation Resistance (Direct method of electrolytic corrosion): 1,000,000 megohms.
3. Rubber electrical insulating tape for protective overwrapping: Silicone rubber with a silicone pressure-sensitive adhesive. When tested in accordance with ASTM D1000, the tape shall have the following minimum properties:
   a. Thickness; 15 mils.
   b. Tensile Strength: 11 pounds per inch.
   c. Elongation: 525%.
   d. Dielectric Strength: 13,000 volts
   e. Insulation Resistance (Indirect Method of Electrolytic corrosion): 1,000,000 megohms.
4. Arcproof Tape: Flexible, conformable organic fabric, coated one side with a flame-retardant flexible elastomer-self-extinguishing, with the following minimum properties:
   a. Thickness, ASTM D1000: 55 mils.
   b. Tensile strength, ASTM D1682; 50 pounds per inch.
   c. Thermal conductivity, ASTM D1518; 0.478 btu/hour/square foot/degrees F.
   d. Electrical Arc Resistance: Withstand 200 ampere arc for 40 seconds.
5. Mark each tape package to indicate shelf-life expiration date.
6. Glass Cloth Electrical Insulating Tape (for use with arcproof tape): Woven glass fabric; when tested in accordance with ASTM D1000, the tape shall have the following minimum properties:
   a. Thickness: 7 mils
   b. Breaking Strength: 170 pounds per inch.
   c. Elongation: 5%.
   d. Dielectric Breakdown: 2,500 volts.
   e. Insulation Resistance (Indirect Method of Electrolytic Corrosion): 5,000 megohms.

2.12 WIRING DEVICES

A. General. Wiring devices include switches, receptacles and special outlets installed in raceway or conduit boxes, complete with cover plates.

B. Switches

1. AC tumbler-toggle switches: Meeting minimum requirements of UL 20 and further requirements herein specified and of specification grade, heavy duty, of the type indicated.
2. Provide switches that operate in any position and are fully enclosed with entire body and cover of molded phenolic, urea or melamine. Do not use fiber, paper or similar insulating material for body or cover.
3. Equip switches with metal mounting yoke with plaster ears, insulated from the mechanism and fastened to the switch body by bolts, screws, rivets or other substantial means that meet test requirements.
4. Provide a green-colored equipment grounding screw on the yoke.

5. Provide the section of the yoke normally intended to bear on the surface outside the box with a minimum over-all dimension of 3/4 inch, measured at right angles to the longitudinal axis of the yoke.
6. Make switch contacts between silver or silver alloys.
7. Switches shall be back and side wired with terminals of screw or combination screw-clamp type.
8. Terminal Screws: No. 8 or larger, captive or terminal type.
9. Provide access holes for back wiring.
10. Wiring terminals capable of receiving and holding proper wire sizes as shown below:

Switch Rating	Wire Size, AWG No.
20 amperes	12 and 14
30 amperes	10

C. Switches for general use shall be fully rated at 20 amperes, 120 volts. Actual connected lamp wattage not to exceed the following:

Switch Rating at 120-Volts	Maximum Wattage Allowed 120 Volts
20 amperes	1,400

2.13 RECEPTACLES AND PLUGS

A. Configuration and requirements for connector and outlet receptacles; UL 498 and NEMA WD 1 for heavy duty general use type.

B. Receptacles: Fire-resistant nonabsorptive, hotmolded phenolic composition or equal bodies and bases with metal plaster ears integral with supporting member.

C. Type: Flush type, except where otherwise indicated.

1. Wall receptacles; Single or duplex as shown on the Contract Drawings.
2. Provide receptacles and plugs (caps) with light-colored terminal facilities for neutral connections, amber or brass colored for phase conductor connections, and green-colored hexagonal machine screws for the equipment grounding conductor or connections.
3. All contracts of the receptacles, including the grounding contract: Double grip bronze type with spring steel backup clips so that both sides of each male prong of the plug will be in firm contact.
4. Provide all receptacles with self-grounding clip or mounting strap screws.
5. Ground fault circuit interrupter duplex receptacles shall be 120 volt, 60 Hz, 15 ampere with built-in test, reset buttons, and ground fault tripped indication. They shall interrupt the circuit within 1/30th of a second on a 5 milliampere earth leakage current. They shall be designed for end of run installation or with provisions for feeding through to protect other outlets on the

circuit. Maximum circuit capacity for the latter shall be 20 amperes. The receptacles shall be furnished with necessary wire connectors, clips, mounting scores and instruction.

2.14 COVER PLATES

A. Provide cover plates for each switch, receptacle, and special purpose outlet.

B. Use multi-gang plates for multi-gang boxes.

C. Unless otherwise indicated, use cover plates conforming to FS W-P-455.

D. Provide and install cover plates of brushed stainless steel in power/control shed (see contract drawings).

2.15 DISCONNECTION DEVICES

A. Safety Switch Type Disconnecting Devices: Enclosed, conforming to UL Standards and the following:

1. Heavy Duty Safety Switches (240 Volts AC):
   a. Furnish heavy-duty safety switches having electrical characteristics, ratings, and modifications indicated.
   b. Furnish switches with NEMA 3R General Purpose Enclosures, unless otherwise indicated, and with metal nameplates, front cover mounted, containing a permanent record of switch type, catalog number, and HP ratings.
   c. Furnish handle with visible blades; reinforced fuse clips; nonteasible, positive, quick make-quick break mechanism, and which is pad-lockable in the OFF and ON position.
   d. Furnish switches meeting NEMA (exterior use) requirements.

PART 3 - EXECUTION

3.1 GENERAL

A. Install all items in their proper locations as shown on the Contract Drawings, rigid and secure, plumb and level, and in true alignment with related and adjoining work. Do not weld electrical materials for attachment or support.

B. Furnish anchor bolts and anchorage items as required, and field check to ensure proper alignment and location. Provide templates, layout drawings, and supervision at the job site to ensure correct placing of anchorage items in concrete. Check embedded items for correctness of location and detail before concrete is placed.

C. Install supporting members, fastenings, framing, hangers, bracing, brackets, straps, bolts and angles as required to set and connect rigidly the work.

D. Control erection tolerance requirements to not impair the strength, safety, serviceability, or appearance of the installations, as approved by the Engineer.

E. The trade size, type and general routing and location of conduits, raceways, and boxes shall be as indicated.

F. Install individual conductors in conduits, raceways, cable trays, ducts, and trenches and multiple-conductor sheathed cables as shown on the Contract Drawings to complete the wiring systems.

G. Install switches, receptacles, special purpose outlets, and cover plates complete in a neat manner in accordance with the NEC and local electrical codes.

3.2 CONDUIT AND FITTINGS

A. Metallic (rigid galvanized steel & PVC coated rigid galvanized steel) Electrical Conduit

1. Install metallic conduit in accordance with the NEC and as indicated. Prevent concrete and other materials from obstructing the conduit. Pack all outlet, pull and junction boxes with paper prior to pouring concrete ends of embedded conduit. Do not use conduit smaller than 3/4-inch diameter.
2. Make all conduit bends in accordance with the NEC, with not more than 3 bends per run. Where more than 3 bends are required in a particular run, install pull boxes as required to facilitate pulling conductors.
3. Unless otherwise indicated, terminate metallic conduit installed for future extension with flush couplings set to finished floor level.
4. Provide metallic numbering tags indicting the conduit number on the end of conduit. Identify train control and communication conduit as indicated.
5. Properly support conduit to be embedded to maintain correct location and spacing during concreting operations. If necessary, provide suitable metal supports for this purpose.
6. Install conduit so that any moisture collecting in the conduit will be drained to the nearest outlet or pull box.
7. Whenever exposed or buried conduit passes through an expansion or contraction joint in the structure, install the conduit at right angles to the joint, and provide an approved conduit expansion joint at the joint. Paint the conduit with an approved bituminous compound for one foot on each side of the expansion couplings.
8. Provide expansion joints in conduit runs where required to compensate for thermal expansion.
9. Rod and swab embedded conduit after installation to remove foreign matter, which may have worked in at the joints. If obstructions are encountered which cannot be removed, or if any conditions exist which may result in damage to wires and cables pulled through the conduit, install new conduit at no additional expense to the Authority.
10. After the conduit has been rodded and swabbed, repack boxes and protect conduit ends to prevent any foreign material from entering the conduit.
11. Where metallic conduit is exposed to different temperatures, seal the conduit to prevent condensation and passage of air from one area to the other.
12. Use only conduits that are electrically and mechanically continuous and connect to the structure ground system. Secure continuous ground by bonding where required.
13. Apply conductive antisieze compound to the threads of threaded rigid conduit joints. Do not use compounds containing lead. Terminate the conduit in appropriate boxes at all motors, switches, outlets, and junction points.
14. When field cutting of conduit is required, thread and ream the conduit to remove any rough edges. Where a conduit enters a box or other fitting, provide a bushing to protect the wire from abrasion. Provide insulation type bushings and double locknuts on ends of rigid conduits terminating at steel boxes, panelboards, cabinets, motor starting equipment, and similar enclosures.

15. Support individual horizontal conduits not larger than 1-1/2 inches diameter by means of one-hole pipe straps with back spacers or individual pipe hangers.
16. Space conduits installed against concrete surfaces away from the surface by clamp backs or other approved means.
17. Support individual horizontal conduits larger than 1-1/2 inches diameter by individual pipe hangers.
18. In dry locations, spring steel fasteners, clips, or clamps specifically designed for supporting exposed single conduits may be used in lieu of pipe straps or pipe hangers.
19. Hanger rods used in connection with spring steel fasteners, clips, and clamps shall be either 1/4-inch diameter galvanized steel rods or, if concealed above a suspended ceiling, galvanized perforated steel strapping. Do not use wire for support of conduit.
20. Support parallel conduits at the same elevation on multiple conduit hangers or channel inserts. Secure each conduit to the pipe hanger or channel insert member by a U-bolt, one-hole strap, or other specially designed and approved fastener suitable for use with the pipe hangers or channel inserts.
21. Space supports not over 10 feet on centers for vertical conduits spanning open areas. Securely anchor conduit at each end and run so as not to interfere with the installation and operation of equipment at the location.
22. Support conduits and raceways above suspended ceilings from either the floor construction above or from the main ceiling support members, using the applicable method specified herein.
23. Install liquid-tight flexible metal conduit so that liquids tend to run off the surface and not drain toward fittings. Provide sufficient slack to reduce the effects of vibration. Running threads are not acceptable. Where necessary for connecting conduits, use right and left hand couplings.

B. Non-Metallic Electrical Conduit

1. Non-metallic electrical conduit includes polyvinyl chloride (PVC).
2. Cap or plug the ends of embedded conduit to prevent concrete and other materials from obstructing the conduit.
3. Sandpaper joints in PVC conduit to remove all burrs, clean and dry the joints, and brush with solvent cement acceptable to the manufacturer before installing.
4. Properly support conduits to maintain the correct location and spacing during concreting operations and, if necessary, provide suitable plastic supports and spacers for this purpose.
5. Wherever buried non-metallic conduit passes through an expansion or contraction joint, or where required to compensate for thermal expansion and contraction, provide a conduit expansion joint. Install the conduit to cross the joint at right angles. In areas of floating slabs, install horizontal runs of conduit beneath the floating slab. Conduit shall pass through the floating slab only where required to terminate in a vertical direction as shown on the Contract Drawings.

C. Pull Wires

1. Use nylon pull wires of tensile strength not less than 240 pounds in each conduit and duct, leave pull wires in ducts and conduit after cleaning.
2. No splices in pull wire will be allowed.
3. Leave ample slack length at each end of pull wire.

D. Filling of Openings. Wherever slots, sleeves, or other openings are provided in floors or walls for the passage of raceways, including bus ducts, fill such openings as follows:

1. Use fire-resistive filling material for openings similar to the material of the wall/surface being penetrated, and finish to prevent passage of water, smoke, and fumes.

2. Seal all above ground conduit penetrations with filling material that matches, and is flush with the surface being penetrated.

3.3 INSERTS

A. Channel Inserts. Install embedded channel inserts with the slotted face flush with the finished concrete surface.

B. Spot Inserts

1. Install with the insert face flush with the finished concrete surface, firmly embedded, with no evidence of movement.
2. Test selected inserts, as required by the Engineer, by suspension of 800 pounds of weight from the insert. If there is evidence of failure, replace the inserts in a manner satisfactory to the Engineer.

3.4 SURFACE METAL RACEWAYS

A. Securely ground surface metal (NEMA 3R) raceways to outlet boxes or to backplates and fixtures by means of bolts, screws or other approved means and as specified in Section 16450 - GROUNDING.

B. Install surface metal (NEMA 3R) raceways where indicated, in accordance with the NEC. Use fittings and accessories designed for the raceway.

3.5 OUTLET, JUNCTION AND PULL BOXES

3.6 WIRING

A. General

1. Furnish wires and cables to the site in unbroken standard coils or reels, to which shall be attached a tag bearing the manufacturer's name, trade name of the wire, and the UL label for 600 volt wire and cable.
2. Provide all wiring complete as indicted. Provide ample slack wire for service connections and extensions.
3. Do not bend cables during installation, either permanently or temporarily, to radii less than 12 times the outer diameters, except where conditions make the specified radius impracticable, and shorter radii are permitted by the NEC and NEMA Standard WC 7, Appendix N.
4. Neatly and securely bundle cable conductors located in branch circuit panelboards, cabinets and control boards. Use nylon bundling straps.

B. Wire Pulling

1. Install wire and cable in conduit as indicated. Do not pull wiring into any conduit until conduits and outlets have been thoroughly cleaned and swabbed to remove water and debris. Do not use block or tackle or other mechanical means in pulling conductors smaller than No. 2 AWG in raceways.

2. Provide suitable installation equipment to prevent cutting and abrasion of conduits and wire during the pulling of feeders. Use lubricant and installation procedure as recommended by the cable manufacturer, and as approved by the Engineer.
3. Use masking or other means to prevent obliteration of cable identifications when solid color coating or colored tracers are used.
4. Pull together all cables to be installed in a single conduit.

C. Cable Supports. Install cable supports for vertical feeders in accordance with the NEC.

D. Splices and Terminations

1. Make wire and cable splices only in outlet, junction or pull boxes, or in equipment cabinets. Splices in conduit or raceway will not be permitted. Make splices by means of compression type connectors, and cover with tape to an insulation level equal to that of the cable.
2. Use positive type connector installation tools as recommended by the manufacturer.
3. Mechanical hand tools, with dies for each conductor size, recommended by the manufacturer, may be used on conductor sizes through No. 4/0.
4. For conductor sizes larger than No. 4/0, use hydraulic tools with hexagonal or circumferential installing dies for each conductor size, as recommended by the manufacturer.
5. For inspection purposes, clearly mark die numbers on the installed connectors.
6. Before installation, apply anti-corrosion electrical joint compound to conductors and terminal bolting pads.

3.7 WIRING DEVICES

A. Locate switches four feet above finished surface, or as indicated on drawings.

B. Attach receptacles rigidly to outlet box by means of two screws.

C. Mount receptacles in watertight (NEMA 3R) cast type outlet boxes with threaded hubs or bosses and equipped with gasketed cover and captive cap of the screw or twist type.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

A. No separate measurement or payment will be made for work required under this Section. All costs in connection therewith shall be considered incidental to the item or items of work to which they pertain.

END OF SECTION

SECTION 16195

ELECTRICAL IDENTIFICATION

PART I - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies the furnishing and installing of nameplates and labels, wire and cable markers, and conduit markers. Engraved nameplates shall be designed, furnished and installed for every major piece of electrical equipment shown on the single-line diagrams. The single-line diagrams are shown on the Contract drawings.

B. Related requirements are included in, but not limited to, the following Sections.

1. Section 09900: PAINTING
2. Section 16050: BASIC MATERIALS AND METHODS FOR ELECTRICAL WORK

1.2 REFERENCES

A. National Fire Protection Association (NFPA)

1. NFPA No. 70 - National Electrical Code

1.3 SUBMITTALS

A. Submit in accordance with Section 01300, except as modified herein.

B. Product Data/Catalog Cuts

1. Nameplates and labels.
2. Wire and cable markers.
3. Conduit markers.

C. Certificates of Compliance

1. Nameplates and labels.
2. Wire and cable markers.
3. Conduit markers.

D. Manufacturer's Instructions

1. Delivery, handling, transportation, storage and protection.
2. Surface preparation, and application/installation of products.
3. Application conditions and limitations of use.

E. Engraved nameplate schedule shall be submitted for review and approval by the Engineer.

F. Submittals required for painting work shall be as specified in Section 09900.

1.4 DELIVERY, HANDLING, TRANSPORTATION, STORAGE AND PROTECTION

Delivery, handling, transportation, storage and protection shall be in accordance with the manufacturer's instructions, unless otherwise required by Division 1.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Conform to requirements of NFPA No. 70.

B. Provide products listed and classified by Underwriters Laboratories, or a testing firm acceptable to authorities having jurisdiction as suitable for purpose specified and indicated.

1. The Contractor shall submit certificates of compliance for products provided.
2. The Contractor shall provide the manufacturer's instructions indicating application conditions and limitations of use stipulated by the product testing agency.

2.2 NAMEPLATES AND LABELS FOR EQUIPMENT

A. Nameplates and Labels

1. Engraved three-layer laminated plastic, black letters on white background.

B. Locations

1. Electrical equipment including, but not limited to, each electrical distribution enclosure and control equipment enclosure, communication cabinets, transfer switches and panels.

C. Letter Sizes:

1. Use 1/4-inch letters for identifying individual equipment and loads.
2. Use 1/4-inch letters for identifying grouped equipment and loads.
3. Use 1/8-inch letters for identifying voltage, phase, and neutral.

2.3 WIRE MARKERS

A. Wire markers shall be manufactured by Panduit, Ideal, 3M, or approved equal.

1. Description: Cloth tape or tubing type wire markers.
2. Locations: Each conductor at panelboard, gutters, pull boxes, outlet and junction boxes and each load connection.

B. Legend

1. Power and lighting circuits: Branch circuit or feeder number indicated on the Drawings.
   a. Control circuits: Control wire number indicated on schematic and interconnection diagrams on the Drawings.

2. Power supervisory control and data acquisition (SCADA) system circuits:

a. Circuits shown on the riser diagrams or schematic diagrams. The riser diagrams and schematic diagrams are shown on the Drawings.

2.4 CONDUIT MARKERS

A. Conduit markers shall be manufactured by Banded Labeling System, Brady USA, Inc., Panduit, or approved equal.

B. Location: Furnish markers for each conduit longer than 6 feet.

C. Spacing

1. Spacing shall be 20 feet on center, unless otherwise specified.

D. Color:

System Name	Color
1. 240 volt system	Per NEC
2. Telephone system	Gray
3. Management information system	Purple
4. Passenger assistance system	Green
5. Public address system	White
6. Closed circuit television system	Black

E. Legend:

System Name	Legend
1. 240 volt system	240 V
2. Telephone system	TS
3. Management information system	MIS -
4. Passenger assistance system	PNRA
5. Public address system	PAS
6. Closed circuit television system	CCTV

2.5 PAINTED CONDUIT IDENTIFICATION

A. Conduit shall be painted for identification purposes. Paint system Identification Number shall be as specified Section 09900 - PAINTING

B. Paint colored band on each conduit longer than 6 feet.

C. Paint bands, 3 inches wide, 20 feet on center, unless otherwise specified.

D. Color

System Name	Color
1. 240 volt system	Per NEC
2. Telephone system	Gray
3. Management information system	Purple
4. Passenger assistance system	Green

5. Public address system White
6. Closed circuit television system Black

2.6 UNDERGROUND WARNING TAPE

A. Underground warning tape shall be manufactured by Panduit, Ideal, Seton, or approved equal.

B. Description: Underground warning tape shall be 6 inch wide plastic tape, colored yellow with suitable warning legend describing: CAUTION - BURIED ELECTRICAL LINES BELOW.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive nameplates, labels and markers, in accordance with the manufacturer's instructions.

3.2 APPLICATION INSTALLATION

A. Application/installation of products shall be in accordance with the manufacturer's instructions.

B. Nameplates and Labels

1. Install nameplates and labels parallel to equipment lines.
2. Secure nameplate to equipment front using screws.
3. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

C. Conduit Identification by Markers

1. Identify conduit using conduit markers.
   a. Apply conduit markers parallel to conduit runs.

D. Conduit Identification by Painting

1. Identify conduit, using paint. Paint shall be field applied.
   a. Painting, including surface preparation, shall be in accordance with Section 09900 - PAINTING

E. Identify underground conduits using underground warning tape. Install one tape per trench at 12 inches below finished grade.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

No separate measurement or payment will be made for work required under this Section. All costs in connection therewith shall be considered incidental to the item or items of work to which they pertain.

END OF SECTION

SECTION 16450

GROUNDING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies furnishing and installing complete system neutral grounding, equipment grounding system for the South Acton Commuter Rail Station's electrical system as shown on the Contract Drawings and indicated herein.

1.2 SUBMITTALS

A. As-Built Drawings. Submit prior to final acceptance of the work, drawings showing complete layout of systems installed including physical location of ground rods to which connections were made.

B. Field Quality Control Test Report. Submit reports complying with requirements of Part 3 "Field Quality Control" Article.

C. Catalog cuts and descriptive literature for materials specified herein and as shown on the Contract Drawings.

PART 2 - PRODUCTS

2.1 BARE GROUND WIRE

A. Soft drawn copper, Class A or Class B stranded, meeting the requirements of ASTM B8; size in accordance with the NEC except where sizes specified herein or shown on the Contract Drawings are larger than those required by NEC; UL listed, Label A for lightning protection conductors. Grounding cable shall be continuous without joints or splices through its length.

2.2 INSULATED GROUND WIRE

A. Copper, Class B Stranded, 600-Volt, 90 degree C, NEC type THWN; meeting requirements of AAR Specifications No. 535.2; sized as indicated; and UL listed.

2.3 PRODUCTS USED FOR COPPER THERMIT WELDED CONNECTIONS

A. Use products for copper thermit welded connections which are the products of one manufacturer and are produced for the specific application for which they are used.

B. Use materials and equipment which meet or exceed the applicable acquirements of the AAR Manual, Electrical Section, Section 13, Chapter 3, Part 6.

C. Coating Materials for Thermit Welded Connections: Use black, rubber based compound coating materials, which are soft, permanently pliable, moldable, and unbacked, not less than 1/8 inch thick, with properties as follows:

Solids	100 percent
Density	12.0 pounds per gallon minimum
Penetration	90-130 ASTM D5
Water Absorption	0.10 percent maximum ASTM D570
Dielectric Strength	500 volts/mil ASTM D149
Volume Resistivity	2,000 megohms-inches ASTM D257 5,000 megohms-cm ASTM D257
Service Temperature	Minus 40 degrees to 160 degrees F.
Chemical Resistance	Melting point, none; flammability, slow burning (ASTM C653); resists alcohol, water, aqueous hydrochloride and sodium hydroxide; dissolved by carbon tetrachloride, naphtha gasoline, mineral spirits, ketones, and benzene.
Highly cohesive and Adhesive	Adheres strongly to metals and concrete and to itself.

2.4 BOLTED GROUNDING CONNECTORS

A. For solderless type made of high strength electrical bronze with silicon bronze clamping bolts and hardware; designed such that bolts, nuts, lock washers and similar hardware which might nick or otherwise damage the ground wire will not directly contact the ground wire.

2.5 GROUND RODS

A. Medium carbon steel core, copper clad by the molten weld casting process; sizes as shown on the Contract Drawings; UL approved.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform testing as specified in Part 3 "Field Quality Control" Article.

3.2 GENERAL GROUNDING REQUIREMENTS

A. General. Provide station electrical grounding complying with procedures of NEC and as indicated.

B. Equipment Ground Conductors

1. Provide each conduit entering power shelter with equipment ground conductor, colored green.
2. Terminate conductor directly on main panel ground bus.

C. White Neutral Conductor. Provide each conduit feeding line-to-ground loads, such as 120 volt control power with both an equipment ground conductor and insulated white neutral conductor.

D. For the Power/Communications/Signal/AFCShed, provide grounding for the 120/240V distribution panels (total of 3) and communications ground bus.

E. Provide grounding the NSTAR meter, Main service disconnect switch and associated equipment.

F. For the Prefabricated Maintenance Building, provide grounding for the dedicated circuits.

G. Provide convenience outlets having ground fault circuit breakers, complying with Section 16050 – BASIC MATERIALS AND METHODS FOR ELECTRICAL WORK.

3.3 EQUIPMENT GROUNDING

A. Wiring, Channels, Cable Trays, Metallic Conduit, Rigid Electrical Metallic Tubing, Flexible Conduits, Metallic Boxes, Panelboards, Generator Frames and Transformer Enclosures. Ground to ground bus with copper ground conductors sized as specified in the Construction Specifications.

B. Lighting Fixtures and Equipment.

1. Accomplish grounding with equipment ground.
2. Provide equipment ground conductor electrically and mechanically continuous from system equipment and neutral ground connection at source of supply to equipment to be grounded.

C. Junction Boxes and Other Enclosures Sized Above Five Square Inches. Securely bond equipment ground conductors to enclosures utilizing equipment ground bus or lug.

D. Ground Electrodes (Rods)

1. Ground rods shall not protrude above finished grade to prevent a tripping hazard.

E. Grounding Conductors

1. All direct buried grounding conductors comprising of the main ground grid for the new power and communications sheds and control cabinets/enclosures and transformer pads shall be installed a minimum of 30 inches below finished grade or ballast.
2. Separate grounding conductors shall be provided for all circuits as required by these Specifications and as indicated on the Contract Drawings

F. Ground Terminations

1. All ground rod electrical connections should be welded with the CADWELD copper-based exothermic welding process. Exothermic welds shall adhere to manufacturer's instructions. Exothermic welds shall be Erico or approved equal

3.4 CONVENIENCE OUTLETS

A. Ground all convenience outlets in accordance with the NEC.

3.5 THERMIT WELDING CONNECTIONS

A. Connect electrical wires together, to reinforcing steel or soldier piles, as indicated, by thermit welding using the manufacturer's recommended molds and size of charges for application.

B. Prepare the material to be welded and perform thermit welding in accordance with manufacturer's instructions.

C. Test completed thermit welds before coating by striking with two pound hammer. If cracks develop, replace welds at no additional expense to the Authority. When required by the Engineer, test the electrical continuity of bonds.

D. Apply coating so that it extends one inch beyond point of attachment to steel member, overlaps wire coating one inch, and provides insulation thickness equivalent to wire insulation, but not less than 1/8 inch in thickness. Do not apply coating material at ambient temperatures below 20 degrees F or above 125 degrees F. Maintain, by an approved method, curing temperature within above temperature range for at least four hours after application of coating. Protect coating by approved means until embedment.

3.6 FIELD QUALITY CONTROL

A. Control Shed and Control Cabinet/Enclosed Ground System Testing

1. General. After installation of the main ground grids and ground electrodes and prior to interconnection of other grounding systems, perform ground resistance testing.
2. Test Report. Provide report-giving results of testing procedures, which shall also include temperature, humidity and condition of soil at time of tests.
3. Ground Resistance Testing
   a. Test Equipment and Method. Perform testing using ground resistance direct-reading single test meter utilizing alternating current fall-of-potential method and two reference electrodes.
   b. Test Procedure
      1) Orient ground electrode to be tested and two reference electrodes in string line spaced minimum 50 feet apart.
      2) Drive two reference electrodes five feet deep.
   c. Resistance Test Value. The maximum allowable resistance value of the grounding system for the new power and communication sheds shall be 1 ohm. If it is found that the resistance value of the grounding system exceeds 1 ohm, the Contractor shall install additional ground rods in series until the resistance value reaches 1 ohm or less. Additional ground rods shall be spaced no less than 10 feet apart. If, after additional ground rods are installed, excessive resistance readings persist, the Contractor shall notify the Engineer.

B. Miscellaneous Equipment Grounding System Testing

1. Electrical equipment such as power service equipment, electrical manholes and handholes and other electrical apparatus requiring grounding shall meet the resistance test value specified below.
2. Resistance Test Value. The maximum allowable value for electrical apparatus specified above shall be 25 ohms or less. If it is found that the resistance value exceeds 25 ohms, the Contractor shall install additional ground rods in series until the resistance value reaches 25 ohms or less. Additional ground rods shall be spaced no less than 10 feet apart. if after additional ground rods are installed, excessive readings persist, the Contractor shall notify the Engineer

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Separate measurement and payment will not be made for work required under this Section, but all costs in connection therefore shall be included in the items of work to which they pertain.

END OF SECTION

SECTION 16471

DISTRIBUTION AND BRANCH CIRCUIT PANELBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies distribution and branch circuit panelboards and panelboard enclosures.

B. Related Work- Related work should be performed under sections 16050-Basic Methods for Electrical Work, 16450-Grounding, and 08711-Door Hardware

1.2 SUBMITTALS

A. Submit for approval catalog cuts, drawings, and data, for each item, indicating the following:

1. Manufacturer's model number or item identification.
2. UL listing and rating.
3. Critical dimensions and mounting arrangements.
4. Complete replacement parts list.

B. Enclosures: Materials and methods of construction, door arrangement, conduit hub and knockout locations, and identification of intended panelboard.

C. Circuit Breakers: Circuit for which intended, voltage ratings, insulation level, current rating, and interrupting ratings.

D. Panelboards: Base material, general arrangement, location and identification of each circuit breaker and the circuit breaker information specified above, location and identification of all terminals, location of barriers, applicable UL 67 Tables A through F information, wiring diagrams, and identification of the enclosure for which intended.

1.3 QUALITY ASSURANCE

A. Manufacturing: Manufacturer's and UL standard inspecting and testing procedures.

B. UL Labels

1. Each factory-assembled enclosure panelboard.
2. Each panelboard shipped separately.
3. Each circuit breaker shipped for field mounting.

C. Listing and Special Marking

1. Each enclosure shipped separate from panelboard shall be UL listed and marked with the identification of the panelboard for which intended.
2. Raintight marking for all enclosures exposed to weather or unusual spray or moisture conditions.

PART 2 - PRODUCTS

2.1 GENERAL

A. Distribution and branch circuit panels shall be enclosed, completely factory assembled type unless otherwise approved, dead-front grounded enclosure complete with circuit breakers as shown on the Contract Drawings. Design and assemble interiors so that any individual breaker can be replaced without disturbing adjacent units or without removing main bus connectors. Design main buses and back pans of distribution panelboards such that branch circuits may be changed without additional machining, drilling or tapping. Provide cutout type only where specifically indicated.

B. Materials of construction: UL 67; appropriate NEMA Standards, UL listed.

C. Field Wiring and Miscellaneous Hardware: Section 16050 – BASIC MATERIALS AND METHODS FOR ELECTRICAL WORK and Section 16450 - GROUNDING, UL listed.

D. Field Touch-up or Repainting Paint: As recommended by enclosure manufacturer.

2.2 CIRCUIT BREAKERS

A. In Battery Rooms and Other Hazardous Locations: UL 877, class appropriate to hazard, appropriate rating or as indicated.

B. Circuit Breakers of the Same Ratings: Interchangeable, quick-make, quick-break.

C. Circuit Breakers for 125 Volt Battery Power: Rated at 10,000 Amperes interrupting at 250 Volts DC; 2-pole unless otherwise indicated.

D. Breakers shall have an interrupting rating not less than 20,000 amperes rms symmetrical or as otherwise indicated. The breaker trip element; enclosed compensated for temperature rise and calibrated to 40°C ambient temperature.

E. Circuit breakers shall be of the indicating type, providing "on", "off", and "tripped" positions of the operating handle. When the breaker is tripped automatically, the handle shall assume a middle position between "on" and "off". All multi-pole breakers shall be so designed that an overload on one pole automatically causes all poles to open. The circuit breaker shall be quick-make and quick-break on manual as well as automatic operation and shall have inverse time characteristics secured through the use of a bimetallic tripping element supplemented by a magnetic trip.

F. The branch circuit breakers shall have fixed thermal-magnetic trips, of values shown on the Contract Drawings, and shall have minimum UL listed interrupting ratings of 20,000 symmetrical amperes at 208Y/120 and 240/120 Volts. All breakers shall be bolt-on type.

G. Provide handle "lock-on" devices on the circuit breakers indicated on the schedules. "Lock-on" devices shall prevent accidental deenergization of critical circuits. These devices shall be trip-free, permitting the circuit breaker to trip automatically on overload. Provide one "lock/on" device for every four circuit breakers indicated in the lighting and power panels. Furnish the Authority for future use all "lock-on" devices not installed.

H. All circuits, which serve convenience outlets, shall be protected by ground fault circuit breakers for personnel protection.

I. Main panel circuit breaker must be GFI.

2.3 ENCLOSURES

A. Panel type with butt hinged door or doors with cylinder housing capable of receiving cylinder specified in Section 08711 - DOOR HARDWARE. Trim must also be hinged.

B. Mark enclosures for easy identification of intended panelboard unless panelboard is shipped factory installed.

C. Enclosures for mounting exposed to the weather or in unusually wet locations shall be rainproof type, and so marked. All others shall be standard type.

D. Directory: Card type, suitable for typewriting directory of circuits, mounted under unbreakable transparent protective cover set in metal frame on inside of door, with provisions for:

1. Panel designation and panel or switchboard from which panel is fed.
2. For each circuit breaker, complete information concerning the circuit controlled, including the voltage and the area, room number, or appliances served; or Main or Spare as applicable.

E. Finish: Thoroughly cleaned, phosphatized or equivalent, coated with at least one coat of corrosion resisting paint inside and out suitable for the material, and painted with manufacturer's standard electrical grey paint suitable for touch-up or repainting in the field.

2.4 PANELBOARDS

A. UL listed and UL labeled unless shipped as a factory-mounted component of a UL labeled enclosed type panelboard with bases not over 48 inches top edge to bottom edge.

B. Interrupting Devices: Circuit breaker type except where cutouts, meter fuses, or switches are specifically indicated. All cutouts, fuses and pull-out type UL listed.

C. Panelboards, where shown on the Contract Drawings, shall be equipped with a main protective device consisting of a three-pole switch and current limiting fuses. Ratings shall be as indicated on the panelboard schedules.

D. Panelboards shall be furnished with an insulated solid neutral bus and a suitable grounding, bus-connected to interior of panel enclosure for termination of green equipment grounding conductor.

E. Panelboards shall have provisions, including space, terminals, and bus capacity, for future addition of at least one and not less than 10% of the total outlet circuit breakers of each rating. Close extra spaces with spare breakers.

F. Terminals: Rated solderless type, suitable for either copper or aluminum conductors sized at maximum rated terminal capacity.

G. Buses and Connecting Straps: Solid copper, main bus rated at the sum of the branch circuit ratings, including motor loads in accordance with Section 430-24 of the National Electrical Code plus 100% of the sum of the trip ratings of the spares specified in paragraphs above, but in no case less than specified in UL 67. Full neutral bus and separate ground bus.

H. DC Circuits: Completely segregated from ac circuits in UL approved manner, with each DC terminal separated from other DC circuits by UL approved DC type barriers.

I. Color markings per optional provision UL 67, Paragraph 143.

J. Marking for easy identification of intended enclosure unless shipped factory mounted in enclosure.

K. Permanent numerical identification by each breaker space.

L. Spare breaker spaces closed with spare breaker. Must provide space for 100% spare breakers.

M. Panelboard cabinets shall have means for securing, supporting, and adjusting the panelboards and trim.

N. Panelboard gutter space shall be as required by the NEC.

O. Where gutter spaces are occupied by feeder cables, gutter spaces shall be increased as required.

P. Panelboard cabinets shall be ordered without knockouts.

Q. Panelboards shall be furnished with an insulated solid neutral bus and a suitable grounding bus connected to interior of panel enclosure for termination of green equipment grounding conductor.

R. All panelboard covers and doors must be hinged.

2.5 ENCLOSED PANELBOARDS

A. Conform to requirements specified in Part 2 "Panelboards" Article.

B. UL Enclosed Panelboard Label: Form 6, Form 12, or general. Enclosed cutout label only where cutout is specifically indicated.

2.6 DISTRIBUTION PANELBOARDS

A. Distribution panelboards shall be 120/240 Volt, single phase, three wire, and shall have bolt-in type (20 KAIC rated) molded case circuit breakers in the quantities and sizes indicated.

2.7 POWER PANELBOARDS

A. Power panelboards shall be 120/240 Volt, single phase, three wire, and shall have bolt-in type (20 KAIC rated) molded case circuit breakers in the quantities and sizes indicated.

2.8 LIGHTING PANELBOARDS

A. Miscellaneous power and lighting panelboards shall be 120/240 volt, single phase, three wire, and shall have single pole, bolt-in type (20 KAIC rated) molded case circuit breakers in the quantities and sizes indicated.

2.9 MISCELLANEOUS POWER AND LIGHTING PANELBOARDS

A. Miscellaneous power and lighting panelboards shall be 120/240 Volt, single phase, three wire and shall have 20,000 Amp interrupting capacity bolt-in molded case circuit breakers in the quantities and sizes indicated.

PART 3 - EXECUTION

3.1 GENERAL

A. Prior to commencing installation, verify that all surfaces upon or in which enclosures are to be mounted are properly prepared and that all pre-mounting wire pulling has been completed and properly tagged. Take corrective action if necessary.

B. Verify that enclosure mounting provisions are suitable for intended mounting. Make corrective adjustments, if necessary.

C. Verify that all factory-installed circuit breakers are correct rating for the applicable circuit application as indicated. Take corrective action if necessary.

D. Install panelboards in enclosures in accordance with manufacturer's instructions, if practicable before mounting enclosure.

E. Complete all directory cards with the information indicated in Part 2 "Enclosures" Article above. Typewrite information on directory cards.

3.2 ENCLOSURES AND PANELBOARDS

A. Install at indicated or approved locations in accordance with manufacturer's instructions, and at convenient operating height such that no manually operable device will be within 2- 1/2 feet of the floor or more than 6-1/2 feet above the floor, and so that the mid-point of all manually operable devices is as nearly as practicable 5-1/2 feet above the floor without exceeding the above maximum height limitations.

B. Adjust straight and plumb and fasten securely in place. Align and securely and independently fasten each section of multi-section enclosures.

3.3 WIRING

A. Perform wiring in accordance with Section 16050 – BASIC MATERIALS AND METHODS FOR ELECTRICAL WORK, and UL 67; NFPA 70, Article 240; and manufacturer's instructions.

B. Perform circuit wiring as specified in Section 16050 – BASIC MATERIALS AND METHODS FOR ELECTRICAL WORK.

C. Ground as specified in UL 67; NFPA 70, Articles 200 and 250; and Section 16450 - GROUNDING. Connect neutral wire directly to neutral bus, and ground wire to ground bus, in same panel as circuit interrupting device.

D. Neatly route, harness and support conductors in gutters, wiring spaces and compartments. Bending radii not less than recommended by conductor manufacturer.

E. Verify that circuits are wired as indicated and are continuous and free of shorts. Energize, as permitted by the Engineer, and test each circuit, including lights and outlets. Check voltage at outlets. Test other electrical equipment as recommended by manufacturer. Measure ground bus and grounded conductor resistance to true ground, resistance between enclosure and ground bus, between pairs of bus bars, and between insulation and ground bus. Resistances shall be within limits specified in Part 3 "Acceptance Tests" Article. If resistances are not within the limits specified, the cause of such resistances shall be determined and corrective action shall be taken to obtain the acceptable resistances specified.

F. Install bonding jumpers from conduits entering cabinets to ground bus.

3.4 ACCEPTANCE TESTS

A. Repeat the tests specified in Part 3 "Wiring" Article in the presence of and to the satisfaction of the Engineer. Test operation of each circuit and circuit control a minimum of 10 times and operation of each circuit continuously for a minimum of 1/2 hour. For all lighting circuits, comply with additional requirements specified in Section 16500 - LIGHTING.

B. Acceptable Resistances

1. Ground Bus and Grounded Conductor to True Ground: 2 Ohms maximum.
2. Between Enclosure and Ground Bus: less than 0.1 Ohm.
3. Between Pairs of Bus Bars: 50,000 Ohms minimum.
4. Between Insulation and Ground Bus: 10 Megohms minimum.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

A. Separate measurement and payment will not be made for work required under this section, but all costs in connection therefore shall be incidental to the items of work to which they pertain.

END OF SECTION

SECTION 16500

LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Work Included: This Section specifies lighting systems, complete and operable, as indicated, including fixtures; fixture mounting hardware including brackets, canopies, hangers, and poles; lamps; auxiliary lighting equipment; and lighting control equipment for the South Acton Commuter Rail Station.

1. The equipment and materials required under this Section shall be in accordance with the general description as indicated in Section 16050 - BASIC MATERIALS AND METHODS FOR ELECTRICAL WORK.
2. Lighting levels shall exceed code minimums for safety and security purposes.
3. Light control panels to be located separately from Communication, Traction Substations, and Unit Substation rooms.

B. Related Work: The equipment and materials required under this Section shall be in accordance with the general description as indicated in Section 16050 - BASIC MATERIALS AND METHODS FOR ELECTRICAL WORK.

1.2 SUBMITTALS

A. Submit shop drawings, catalog cuts, descriptive information and photometric data for all lighting fixtures, lamps, auxiliary lighting equipment, lighting control equipment, and mounting hardware. Photometric data to include a computerized print-out detailing the entire finished area being lighted by the submitted luminaires detailing a statistical summary of maintained illuminance levels (MF-.65) on the platform by means of a grid spaced no further than 3 feet on center at a scale of 1" = 8'-0" accompanied with a copy of all input data used to create report. Approval of printout and lighting calculations will be made by the Engineer prior to manufacture of any material.

B. Submit manufacturer's installation instructions detailing the installation procedures and recommended maintenance procedures that will comply with the warranty specified in Section 16500-1, 1.02, D.

C. If specified, before production is commenced, submit a sample fixture of each style, mounting and lamp arrangement specified. Reports indicating that required tests specified have been successfully completed shall accompany each pre-production sample at the time it is submitted. The sample, if approved, will be retained until completion of the work to confirm quality conformance to the prescribed requirements herein. Provide the sample for operation at 120 volts with six-foot cord and plug.

D. Sample for finishes and colors:

1. Submit samples for acceptance showing nominal color(s) and gloss, and the high and low color and gloss range(s) within which the production materials will be processed.
2. Identify samples as to alloy, pretreatment and color.

3. Hold Point. Do not begin processing of production materials until Engineer's written approval of samples has been obtained.
4. Maintain variation in color of installed materials to the color range established by the acceptance samples.

1.3 QUALITY ASSURANCE

A. Fixtures and auxiliary equipment shall be listed, labeled or certified by UL.

B. Replace lamps, which fail within 90 days after final acceptance, at no cost to the Owner.

C. Installation Tolerances: Deviation from location, alignment and mounting height: 1/2 inch noncumulative in any unit or continuous run of fixtures.

1.4 PRODUCT DELIVERY, STORAGE & HANDLING

A. The Manufacturer is required to ship the lighting fixtures, poles, and accessories securely packaged and labeled for safe handling during shipment to avoid damage or distortion.

B. The Contractor is responsible for storing lighting fixtures, poles and accessories in a secure and dry facility and in original packaging to prevent soiling, physical damage, wetting or corrosion prior to installation.

C. Contractor must provide for storage inspection by the Engineer after fixtures have been delivered.

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURES

A. General Requirements

1. Provide lighting fixtures, complete and ready for service, in compliance with UL 57, of the number, type, material, finish, electrical components and characteristics, and with all necessary hardware and auxiliary equipment indicated.
2. The fixtures shall be clearly marked with manufacturer's name and catalog number, voltage, acceptable lamp type, maximum wattage, ballast type, and self-protection, if any. The fixtures shall be identified with standard lamp type and wattage on the exterior of the fixture housing visible from ground level. Two-inch adhesive labels with a number indicating wattage and color signifying lamp type shall be provided.
3. Fixtures shall be rain-tight and dust-tight for use along trackways, for outdoor use, and as indicated. Fixtures must meet IP55 test for water and dust.
4. Fixtures shall be of the same design shape and supplied by the same manufacturer. Luminaires for the project are broken down as follows:

   Stairwells, sidewalks and platforms will use a 175 watt metal halide luminaire with a fixture (housing) dimension measuring 12" x 17" x 6", or as shown on the contract drawings.
   Canopies will use a 100 watt Metal halide luminaire (direct/indirect) with an (inverted) fixture (housing) dimension measuring 12" x 17 x 6", or as shown on the contract drawings. Canopy

Arm fixtures shall utilize a 75 wall metal halide luminaire. All canopy fixtures shall be UL approved for raintight use.

B. Materials

1. Thicknesses, gauges and tempers of products: indicated, and as recommended by the manufacturer for the specific finish, proper forming operations and structural requirements.
2. Lighting sheet for reflector material: Prefinished aluminum, minimum thickness 0.032 inch, architectural Type 1 with Class M1, anodic coating providing 83% reflectively.
3. Concrete for base foundations: Section 03300 - CAST-IN-PLACE CONCRETE
4. Acrylic lenses: 100% virgin acrylic plastic.
5. Polycarbonate lenses and diffusers: Injection molded, crystal clear material, polycarbonate.
6. Lenses to be clipped and hinged.

C. Finishes

1. Finishes shall be in accordance with the manufacturer's recommendations for the specific application.
2. Commence no finishing operations until fabrication and forming operations have been completed.
3. Aluminum work to be anodized shall be given a preanodic treatment followed by an architectural Class 1, anodic coating as described by the Aluminum Association.
   Anodize aluminum in accordance with procedures established by alloy manufacturer to achieve color within specified range.
   Apply a clear organic protective coating to exposed aluminum surfaces that may experience prolonged contact with caustic material, i.e., concrete, plaster.
4. Baked enamel: Factory applied to clean surfaces prepared with a chromate conversion coating, and prime coating, as indicated.
5. Porcelain enamel coating: In accordance with the requirements of Porcelain Enamel Institute, PEI-S-100.
6. Galvanized coating: Hot-dip galvanized or hot-zinc conforming to ASTM A 386. Where painting of the galvanized surface is indicated, prepare the surface with vinyl acid wash primer with polyvinyl butyral resin 56 pounds, 80 gallons zinc chromate pigment and phosphoric acid.

D. Electrical Components

1. Lamp holders and sockets: Class and style recommended by the lamp manufacturer for the specified lamp required by each fixture design and rated for 660 watts, 600 volts or as indicated. Rigidly and securely fastened to the mounting surfaced with the necessary provisions to prevent lampholder from turning and front removable without dismantling any part of the fixture. Located in the lighting fixtures to place each lamp, of size specified, in proper position with relation to the fixture design specified, clearly marked to indicate manufacturer lamp type and voltage and appropriate listings.
   High intensity discharge (HID) lampholders: Glazed porcelain body with nonferrous metal components of heavy duty design, vibration resistant, Edison-based lampholders in accordance with the applicable requirements of UL 496.
   1) Metal halide lamps that are to be operated in the horizontal position: Position oriented mogul base socket.
2. Ballasts: Ensure ballast operating characteristics comply with the recommendations of the lamp manufacturer with regard to lamp electrical characteristics. Provide ballasts suitable for the line voltage with 0.9 power factor, and maximum current crest factor of 1.8. The ballast shall provide reliable lamp starting at the minimum temperature indicated, and operate in ambient

temperatures up to 105°C with maximum ballast case temperature of 90°C. Each ballast shall be securely mounted inside the fixture, in such a manner as to obtain the necessary heat dissipation. High intensity discharge ballasts shall conform to the applicable requirements of UL 1029. Fluorescent ballasts shall conform to the applicable requirements of UL 935.
Metal halide lamps: Operated by a lead peaked auto, LPA, type ballast. The ballast shall provide reliable single lamp starting at minus 20°F, and allow plus or minus 10 percent lamp watts variation for a plus or minus 10 percent input voltage variation.
One light fixture per ballast.
Use of remote ballasts shall be restricted to canopy arm light fixtures only.

3. Fixture Wiring
Fixture Wires: Stranded tinned-copper construction, not smaller than No. 16 AWG. Insulation: silicone rubber type SF-2 and 200°C rated. Conductor size, temperature rating, voltage rating and manufacturer clearly marked on the insulation of each conductor.
Use wires between lampholders and associated operating and starting equipment of the same ampacity rating as leads from the ballast. Wiring within the fixtures shall conform to the requirements of the NEC.
Tape wires at all points of abrasion. No splices shall be permitted within fixtures other than as required to connect lampholders and ballasts.
Fixture Grounding. Unless otherwise specified, the housing of each ballasted lighting fixture shall be provided with a separate, factory-installed grounding device. The grounding device is to be used for connecting a separate, green, grounding conductor to the fixture housing.
Wireways and wiring channels shall have rounded edges or bushed holes wherever conductors pass through. Insulated bushings shall be installed at points of entrance and exit of wiring.

E. Fixture Hardware

1. Latch and release mechanism, hinges, pins and other retaining parts of fixtures; screws, bolts or other assembly and mounting parts: manufactured of Type 316 stainless steel. All springs: heavy duty stainless steel. All retaining hardware: self-retaining.
2. Frame light transmitting elements of the fixture to permit replacement of panels in the frames without the use of tools other than screwdriver or pliers. Secure panels in the frames in a neat, rattle-free manner that will provide proper tolerance for normal expansion and contraction.
3. Form gaskets, sealants and adhesives subjected to high temperature from silicone rubber. Provide other gaskets of neoprene, or as indicated.
4. Fasteners: Provide bolts, nuts, washers, screws, nails, rivets and other fastenings necessary for proper erection or assembly of work. When exposed to the atmosphere, provide fasteners made of 18-8 stainless steel. Fasteners within the housing shall be made of zinc plated, bright iridite, steel or electrogalvanized, gray. Nuts shall have captive externally footed lockwashers.

F. Welding

1. Locate welds in assemblies to be anodized to conceal visible discoloration in the heat-affected zone.
2. Where weld metal will be exposed after anodizing, select filler alloys to closely match composition of base metal. Comply with parent metal manufacturer's recommendations for such filler alloys.

2.2 FIXTURE MOUNTING HARDWARE

A. General Requirements. Provide the fixtures with brackets, straps, canopies, poles and miscellaneous hardware suitable for the mounting method specified.

B. Secure mounting brackets to housing, quantity and spacing as indicated. When exposed to public view, fabricate and finish hardware in matching material to fixture body. Fabricate internal brackets from sheet steel, zinc coated after fabrication.

C. Canopies, holders and similar parts shall be drawn or spun in one piece with a minimum 0.026 inch finished thickness.

D. Tubing used for supporting member shall be seamless drawn with a minimum of 1/16 inch wall thickness of size and length as indicted.

E. Light poles: Shall be square, straight (non-tapered) one piece construction with one flush-welded vertical seam, designed to support the light fixture at 16'-0" (except as noted) in accordance with Standard Specification Construction Section 16500-2.02, E. Pole manufacturer shall provide a wireway access through the base of the pole to accommodate (3) 1" conduits. The wireway access shall cover the entire inside opening of the pole shaft. Pole heights shall be as indicated on the Contract Drawings. Unless otherwise indicated, all poles shall measure nominally 4" x 4" square and are to be manufactured of the same gauge cold rolled steel. Lighting poles along the Platform shall have a mounting height of 12 feet to the top fixture, as shown on Contract Drawings. Poles shall be capable of supporting sign housings measuring 1'-0¾ in size including brackets as required. Sign housings (Track Number Signs & Train Approach Signs) shall be mounted by means of stainless steel hardware in accordance with Section 5500 (Miscellaneous Metals). Poles where speakers will be located shall have the assembly mounted at the top of the pole centered on the mounting for the luminaires (unless otherwise noted). The installing contractor shall coordinate all drilling patterns with the pole manufacturer to accept luminaire(s), sign housings and speaker assemblies as required for mountings as well as wireway access and conduit connections. Poles with sign housings require a 3"x 5" handhole to be located in line with the top of the sign (9'-0" above finished platform as shown on drawings). The installing contractor shall field verify base conditions and coordinate with base details shown in contract drawings to assure that no field modification of bases will be required. Pole base and anchor bolts shall be covered by a one piece galvanized shroud and secured to the pole base by stainless steel screws.

F. Pole Mounted Fixture Support Arm: Shall be one-piece extruded aluminum measuring 4¼ x 1¾ in section and 5" in length with internal bolt guides and fully radiussed top and bottom. Luminaire-to-pole attachment shall be by internal stainless steel hardware with a gasket to protect from galvanic action and a pole reinforcing plate with a strain relief-wiring device. The arm shall be cut for the specified pole to insure a clean fit.

G. Pole Mounted Fixture Housing: Shall be one-piece die-cast aluminum with integral cooling fins over the optical chamber and electrical compartments. A solid barrier wall shall separate the optical and electrical compartments. There shall be a double-thick wall with gussets on the support-arm mounting end. Fixture finish to match that used for the canopy luminaire.

H. Pole Mounted Fixture Lens, Frame, and Latch: Furnish a one-piece die-cast aluminum lens frame with 1" minimum depth around the gasket flange. Integral hinges with stainless steel pins shall provide no-tool mounting and removal from housing. Single die-cast aluminum cam-latch shall provide positive locking and sealing of the optical chamber by a one piece extruded and vulcanized EDPM gasket. A one piece vacuum formed clear UV stabilized polycarbonate enclosure shall be furnished to maintain the seal in lieu of standard tempered glass lens.

I. Pole Mounted Fixture Reflector Module: Modules shall consist of specular Alzak optical segments rigidly mounted in an aluminum frame that attaches to the housing as a one piece module. Modules shall be field rotatable in 90E lateral increments by loosening 4 stainless steel screws and shall meet or exceed the IES distribution referred to as Type III with a Medium classification. The lamp shall be

held in place by a 5KV pulse rated socket which is pre-wired by the manufacturer with a quick disconnect plug. All wireways to the optical compartment shall be sealed to prevent unnecessary dirt accumulation.

J. Pole Mounted Fixture Luminaire Electrical Assembly: Provide a removable plate which supports the electrical components. The assembly shall be removable by means of stainless steel spring latches or a quick turn fastening device. Quick disconnect plugs shall be incorporated to aid in the removal of the assembly. All electrical components within this assembly must conform to Section 16500, 2.01.D. Electrical Components.

K. Canopy Mounted (direct and indirect) Fixture Housing: Shall be of sealed, captive, extruded aluminum construction with window cut out for regressed lens and silicon gasket. The 100W metal halide fixture housings shall have integral electronic cold weather ballast suitable for 240V operation. The 70W metal halide fixture (canopy arm area) shall have remote mounted ballast with 50' maximum distance, cold weather type and be suitable for 240V operation. The 70W fixture shall have adjustable yoke and allow for side mounting on structural beam.

L. Canopy Mounted Fixture Lens, Frame, and Latch: Furnish a one-piece die-cast aluminum lens frame with 1" minimum depth around the gasket flange. Single die-cast aluminum cam-latch shall provide positive locking and sealing of the optical chamber by a one piece extruded and vulcanized EDPM gasket. Lens shall be tempered glass type with micro-prismatic aperture.

M. Canopy Mounted Fixture Reflector Module: The module shall consist of specular Alzak optical segments rigidly mounted in an aluminum frame that attaches to the housing as a one piece module. All wireways to the optical compartment shall be sealed to prevent unnecessary dirt accumulation.

N. Canopy Mounted Fixture Luminaire Electrical Assembly: Provide a removable plate that supports the electrical components. The assembly shall be removable by means of stainless steel spring latches or a quick turn fastening device. Quick disconnect plugs shall be incorporated to aid in the removal of the assembly. All electrical components within this assembly must conform to Section 16500, 2.01.D. Electrical Components.

O. Finishes

1. Pole Mounted and Canopy Mounted Fixture Housing: A Gray/Galvanized TGIC Thermoset Polyester Powder-Coat 2.5Mil nominal thickness paint shall be applied over a chromate conversion coating to housing, lens frame, latch and support arm.
2. Lighting Poles & Base Cover: Finish shall be hot-dip galvanized conforming to Section 16500-2.01, C, 6.

2.3 LAMPS

A. General Requirements. Provide each lighting fixture with the number, type, and wattage of lamps required by the Contract Drawings. Provide lamps of standard manufacture, readily available, and of the highest efficiency and life consistent with other requirements of the illumination system.

B. Metal Halide Lamps: Clear and provided with position oriented mogul bases. Photometric characteristics shall provide lamp maximum luminous output while lamp operates in the vertical position.

C. Provide an additional 10% spare of each type of lamp installed.

2.4 LIGHTING CONTROL EQUIPMENT

A. General Requirements. Provide lighting control components suitable for the lighting system specified and compatible for interface with other associated control devices. Lighting control components shall be rated for continuous service and operate satisfactorily in every respect while the branch circuit power supply voltage to each system is within a 110 to 240 volt range at 60 hertz. Electrical contacts shall have precious metal surfaces.

B. Lighting Contactors

1. Conform to the applicable requirements of UL 508.
2. Electrically operated and mechanically held.
3. Rated at 600 volts, 60 hertz with ampere rating, number of poles and enclosure as indicated.

C. Time Switches

1. Conform to the applicable requirements of UL 887.
2. Pre-wired with astronomic dial, 36-hour synchronous reserve power motor.
3. Manual on-auto-off bypass switches for up to three individual circuits.
4. Rated at 277 volts, 60 hertz, 40 amperes continuous duty with number of poles, throws and enclosure as rated.

D. Photoelectric Sensor

1. Conform to the applicable requirements of UL 773.
2. Operation in temperature range of minus 50°C to plus 60°C.
3. Dusk to dawn operation with adjustments from two to 50 foot candles with a five-second time delay to preclude false switching.
4. Weatherproof and tamperproof.
5. Acceptable for operation from a supply voltage range of 105 to 285 volts AC.
6. Model/manufacturer type as indicated in the drawings
7. Minimum life at rated load: 8000 on-off operations.
8. Photoelectric sensors shall be mounted facing a northerly direction.
9. 1Photoelectric sensors, upon failure, shall default to the "on lighting" position.

E. Wall Switches

1. Installed where indicated in drawing package.
2. Switches: Single unit, toggle, butt contact, quiet type with an integral mounting strap.
3. Switch Ratings

For 120 volt circuits: 20 amperes at 120 volts AC.

4. Switches shall be connected to the wiring with screw clamp type terminals.
5. Wall Plates

Type 304 stainless steel

Standard designs so the products of different manufacturers will be interchangeable.

PART 3 - EXECUTION

3.1 LIGHTING FIXTURES

A. Install lighting fixtures in accordance with the manufacturer's instructions, complete with lamps, hangers, brackets, poles, fittings, and accessories, ready for operation as indicated. Align, mount and level the lighting fixtures uniformly.

B. Avoid interference with and provide clearance for equipment. Where the indicated locations for the lighting fixtures conflict with the locations for equipment, change the locations for the lighting fixtures by the minimum distances necessary as approved by the Engineer.

C. Lighting fixture supports shall provide support for all the fixtures. Anchor supports to the structural slab or to structural members as indicated. Supports shall maintain the fixture positions after cleaning and relamping.

D. Surface mounted lighting fixtures shall be bracketed rigidly from the mounting surfaces. Provide a 1/4-inch clearance between surfaces when the fixture is flat mounted against concrete surfaces. Nipples carrying wire between fixtures shall be watertight.

E. Exterior fixtures mounted on block or brick walls shall be supported by anchor devices of the expansive lead type. No power driven anchors will be acceptable.

F. Where aluminum is placed in contact with dissimilar materials, except galvanized steel, zinc or stainless steel, treat contact surfaces as follows:

1. When in contact with dissimilar metals, apply a prime coat of zinc chromate primer followed by two coats of aluminum and masonry paint.
2. When in contact with concrete, masonry and plaster, apply to aluminum contact surfaces zinc chromate primer, bituminous paint, aluminum metal and masonry paint or pressure tape.
3. When in contact with wood or other absorptive materials, apply two coats of aluminum house paint to such materials and protect aluminum contact surfaces with bituminous paint.

G. Install fixtures to be pole mounted in accordance with the manufacturer's recommended installation practices as indicated.

H. Provide required lamps in each lighting fixture as soon as fixtures are properly installed.

3.2 BALLASTS

A. Install ballasts, other than those mounted integrally within luminaires, as indicated, and in such a manner that the ballast is protected from weather, moisture, and other atmospheric conditions, and in such a manner that ambient temperature surrounding the ballast will not cause the temperature of the ballast housing hot spot to exceed UL requirements. Voltage drop to lamp, due to remote mounting shall not exceed one percent of the nominal lamp voltage. Secondary ballast conductors for high pressure sodium lamps shall have 1000-volt, high temperature insulation. When more than one ballast is mounted at one location, the minimum spacing between ballasts shall be 6 inches in a horizontal direction and 12 inches in a vertical direction.

3.3 LIGHT POLES

A. Install light poles in accordance with the manufacturer's recommended installation practices as indicated.

3.4 CONCRETE BASES

A. Obtain necessary templates and anchor kits before starting work.

3.5 AUXILIARY LIGHTING EQUIPMENT

A. Install as indicated and in accordance with manufacturer's instructions.

B. Anchor firmly in place.

C. Test and adjust for proper operation in accordance with the manufacturer's instructions.

3.6 LIGHTING CONTROL DEVICES

A. Install lighting control devices in accordance with the manufacturer's recommended installation practices, and as indicated.

3.7 FIELD QUALITY CONTROL AND INSPECTION

A. Inspect luminaires, lamps and associated hardware prior to and after installation to confirm that they are of the quality and type as specified herein and as indicated, and are free of defects and damage.

B. Provide luminaires and lighting equipment to the project site complete, with suspension accessories, canopies, hickey, castings, sockets, holders, reflectors, ballasts, diffusing materials, louvers, frames, recessing boxes, and related items, completely wired and assembled as indicated.

C. Whenever practicable, test lighting systems at the same time that the distribution panelboard or switchboard is tested.

D. Adjust floodlights in accordance with the aiming chart provided by the manufacturer. Make adjustments during darkness to obtain the optimum lighting levels throughout.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

A. Separate measurement and payment will not be made for work under this section, but all costs therefore shall be included in the Contract Lump Sum price for Item 1643.000 - Lighting System.

4.2 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
1643.000	LIGHTING SYSTEM	LS

END OF SECTION

SECTION 16700

POWER WIRE AND CABLE

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies furnishing and installing power wire and cable for the AC power distribution system of the South Acton Commuter Rail Station.

1.2 QUALITY ASSURANCE

A. Material and workmanship shall be of the highest quality assuring durability for minimum life expectancy of 40 years. These cables shall be suitable for use in the environment to be encountered on a railroad system, and underground distribution system. The cables shall also be certified for continuous operation at 90 degrees C in wet or dry locations with no conductor failing in continuity or with loss of insulation to cross or ground less than one (1) meg-ohm.

B. Qualification

1. All wire and cable manufacturers must be approved by the Engineer. The Contractor shall provide all data required for the Engineer's evaluation and shall make the arrangements for any required demonstrations and tests.
2. Qualifications shall be based on the following criteria:
   a. Past Performance and Experience. The cable manufacturer(s) must demonstrate previous successful experience in supplying cable to the railroad industry for use as AC power cables. A list of such installations shall be provided for each cable manufacturer to be considered.
   b. Quality Assurance Program. The manufacturer(s) of cables, in accordance with the requirements of these Specifications, shall be accomplished in compliance with a Quality Assurance Program that meets the intent of the ASQC Standard CI-1968, General Requirements for a Quality Program. Such compliance shall promote a thoroughly tested cable, which will render long service life to the user. Prime concern must be focused on the necessary formal assurance requirements to insure that cable failure cannot be attributed to actions or lack of actions by the manufacturer.
   c. Technical Data. The Contractor shall provide full technical data, which demonstrates compliance with the requirements of these Specifications for each specified cable type the Contractor plans to supply.
   d. Demonstration Tests. The Contractor shall make arrangements with the prospective cable manufacturer(s) to perform demonstration tests as required by the Engineer.
   e. Sample Specimens. The Contractor shall, if requested by the Authority, furnish to the Engineer within 20 days after the Notice-to-Proceed, sample specimens in four (4) foot lengths similar to that which the manufacturer(s) proposes to furnish for each type cable specified herein. The sample specimens shall remain the property of the Authority.
   f. The manufacturer(s) shall certify that he shall comply with the following warranty prior to selection:
      1. The manufacturer(s) warrants that the design, material, and workmanship incorporated in each item of cable shall be of the highest grade and consistent with the established, and generally accepted, standards for aerial and underground cable

for ac power circuits; and that each such item and every part and component thereof shall comply with these Specifications.

2. The manufacturer(s) agrees that this warranty shall commence with the acceptance of each item of the cable, whether the defect be patent or latent, and shall continue for a period of two (2) years after initial satisfactory operation of the item or four (4) years after acceptance of the item, whichever is shorter.
3. The warranty covering any length of cable that shall be replaced by the manufacturer(s) under the above conditions shall be reinstated for a period of two (2) years effective as of the day when said replacement is affected. If the failure is found to be of major importance and affects any other item of cable, the reinstatement of the warranty shall then be extended to cover the item so affected as well, and shall start as of the date of such replacement. The warranty reinstatement provided for in this subparagraph 3 shall apply only to the first replacement or repair of any such item and, in the case of failure of major importance, to the first extension of the said warranty to said affected items.
4. The foregoing warranties are exclusive and in lieu of all other warranties written, oral, implied, or statutory (except as to title and freedom from lien). In no event shall the manufacturer be liable by reason of breach of warranty for special or consequential damages.

C. After Selection

1. The Contractor shall monitor the manufacturer(s) of the wire and cable to assure that the approved Quality Assurance Program is being closely adhered to and that the wire and cable is being manufactured in accordance with these Specifications and the approved submittals.
2. Each finished wire and cable shall be traceable to the test date on file for each step in its manufacturing process.
3. Inspection
   a. The Authority, or its authorized representative, shall have the right to make such inspection and tests as necessary to determine if the cable meets the requirements of these Specifications. The Authority shall have the right to reject cable, which is defective in any respect.
   b. The Authority shall be given ten (10) days advance notice of the date the cable will be ready for final testing so that the Authority may witness the tests, if it so elects.
   c. Physical tests shall be made on samples selected at random at the place of production. Each test sample shall be taken from the accessible end of different reels. Each reel selected and the corresponding sample shall be identified. The number and lengths of samples shall be as specified under the individual tests. All applicable tests for the cable materials and cable construction specified shall be performed.
   d. The manufacturer(s) shall provide, at the point of production, apparatus and labor for making any or all of the following tests under the supervision of the Authority's Inspector or Engineer; to include:
      1. Conductor size and physical characteristics.
      2. Insulation HV and IR tests.
      3. Physical Dimension Tests.
      4. Special tests on materials in coverings.
      5. Final HV, IR, and conductor resistance tests on shipping reels.
   e. Certified electrical and physical test reports shall be furnished for the finished cables no later than the time of shipment. Each test document shall, in addition to the test results, indicate the date the tests were performed and the signature of the manufacturer's authorized representative.

f. The Authority reserves the right to conduct itself, or by its duly authorized representative, those tests it so elects to further satisfy itself that the cable is manufactured in accordance with the requirements of these Specifications.

1.3 SUBMITTALS

A. The Contractor shall submit the following to the Engineer for approval:

1. Each cable manufacturer's Quality Assurance Program.
2. Full technical data for each type of cable which each cable manufacturer intends to supply.

B. The Contractor shall submit two (2) certified copies of the following to the Engineer for approval.

1. Cable test reports for all demonstration tests required by the Engineer.
2. Cable test and inspection reports for tests and inspections required and described by these Specifications.
3. Test reports of cable tests conducted in the field in accordance with approved testing procedures.
4. Certification that each cable supplied complies with the requirements of these Specifications.

C. Information to be supplied by certified cable test reports shall include the following:

1. Report number.
2. Date and location of test.
3. Description of test and test conditions.
4. Complete cable or wire description.
5 Lot, batch, or reel identification number.
6. Quantitative test results.
7. Summary of the test results.
8. Information on the components of the cable tested to include batch numbers and physical and electrical properties.

D. The Contractor shall furnish to the Authority five (5) copies of the cable manufacturer's instructions and procedures for potheading of each type underground cable to be furnished.

1.4 DELIVERY, STORAGE AND HANDLING

A. Packing

1. Products shall be so assembled or packed as to permit convenient handling and to protect against loss or damage during shipment.
2. Wire smaller than No. 4 AWG shall be shipped in cartons or in coils. When shipped in coils, the wire shall be securely bound with a layer of waterproof paper with each turn overlapping the other one-half its width if flat-edge paper is used, or one-third its width if folded-edge paper is used. Wires larger than No. 4 AWG shall be shipped on nonreturnable reels protected by fiberboard covering, bound with a steel strap or wire to prevent damage in transportation.

B. Marking

1. Purchaser's order, requisition and package number, name of Consignor, and name and address of Consignee, shall be plainly marked on outside of cartons, coils or reels.

2. Detail list of cartons, coils or reels shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

C. Handling

1. Each shipment shall be inspected by the Contractor for evidence of damage upon delivery. Any damage such as reels loose from their blockings, damaged protective wrapping or lagging, or broken flanges shall be reported to the manufacturer, the carrier, and the Authority. The Authority reserves the right to reject any cable damaged during the shipment, storage or handling process.
2. Cable reels shall be lifted with a lifting sling and spreader attached to a shaft through the wheel hubs, or with a forklift with tines supporting both reel heads. Lift pressure shall not, at any time, be placed on the cable.
3. Reels shall be rolled only on flat surfaces cleared from any debris. Direction of rolling shall tighten the cable wind marked on the reel.
4. The factory-applied protective wrapping shall be left in place until cable installation. After partial installation of any cable from a reel, the remaining cable shall be resealed and the end tied off.

D. Storage

1. Cable reels shall be stored on a firm paved surface or on cribbing with good drainage. Outdoor storage time shall not exceed the manufacturer's recommendations.
2. Suitable means, such as protective barriers, shall be provided to protect the cables from accidental damage during storage.
3. Security against theft and vandal damage shall be provided by the Contractor at no additional cost to the Authority.

PART 2 - PRODUCTS

2.1 AC POWER DISTRIBUTION CABLES

A. Low Voltage Power Cables (less than 1000 volts)

1. Low voltage power cables less than 1000 volts shall be Type RHH, RHW or USE, intended for use as direct burial, in raceways or aerial applications. Conductors shall be stranded copper per ASTM B-3 or B-8. Insulation shall be cross-linked polyethylene in accordance with NEMA WC 7/ICEA S-66-524.
2. High voltage power cables (both insulated and aerial) shall be installed, provided and terminated by NSTAR.

2.2 CABLE FIREPROOFING TAPE

A. Power cables entering handholes shall be fireproofed in accordance with MBTA Standard Specifications P-127, a copy of which can be found in Technical Appendix TA4.

2.3 CABLE TERMINATIONS

A. Ac power cable terminations shall be in accordance with MBTA Standard Specifications Section 16050, Article 2.14.

2.4 IDENTIFICATION TAGS

A. Identification tags for power and control wires shall be in accordance with MBTA Standard Specifications Section 16050, Article 2.14.

2.5 CABLE IDENTIFICATION

A. Conductors shall be marked indicating the manufacturer's name, conductor size, conductor material, insulation type, voltage rating and year of manufacture repeated every two feet on the outside of the cable jacket.

PART 3 - EXECUTION

3.1 GENERAL

A. The installation of power wire and cable shall conform to applicable sections of the NEC and the requirements as specified herein.

B. The Contractor shall give the Engineer 24 hours notice prior to installing cables.

C. In certain types of installation where the cable cannot be constrained, ample cable slack shall be provided for additional flexibility due to vibration of such equipment.

D. Cables shall not be bent to a radius less than eight (8) times the diameter of the cable during installation or as finally installed.

E. All cables shall be tagged at their termination points. In addition, all cables shall be tagged within handholes, manholes, enclosures, etc. and on each side of any barrier the cable passes through. Cables shall also be tagged at aerial exits from conduit risers.

F. All cable entrance openings shall be sealed with either a compression type fitting or pliable sealing compound after the cable is in place. Sealing compound shall be used to seal the area around cable where the cable emerges from the end of a conduit or pipe. All spare conduits shall be sealed or plugged in an approved manner.

G. Where cables leave conduits, the ends of the conduit shall be fitted with approved fittings for the conduit system.

H. Wherever multiple conductor cables are terminated, the outer sheath of the cable shall be carefully removed to the point of cable entrance. At the end of the cable sheath or covering, two (2) layers of plastic electrical tape shall be applied.

I. Contractor shall arrange the cables to allow free access to all existing cables for maintenance.

J. Cable terminations and splices shall be made in strict accordance with Authority's standards. Terminations and splice fittings for all underground conductors shall be tool applied compression connectors of material

and design compatible with the conductors for which they are used. All spliced ends of cables will utilize a "Raychem" or equivalent watertight seal covering, over the compression lug. This watertight seal covering will have an insulation rating equivalent to the conductor for which it is being used.

3.2 INSTALLATION IN CONDUIT

A. Reels shall be stripped of all nails in outside edges of reel heads before pulling of cable, and shall be conveniently located for feeding cable into the conduit without excessive bending or possible injury to cable by abrasion on the sides of manholes or handholes. Reels shall be jacked to clear ground level by at least six (6) inches before pulling of cable.

B. Cable reels shall be carefully handled to avoid injury to persons or cables. Movement of reels on loading skids or sloping grades shall be controlled by use of a snub line or wedge. Reels shall always be blocked after positioning.

C. Cable shall be pulled into conduits with the use of a pulling eye approved by the Engineer. Pulling ropes shall be attached to the pulling eye with ball-bearing swivels to prevent twisting of cable during pulling.

D. Cable shall be pulled into conduits under moderate tension. Manufacturer's recommended maximum pulling tension shall not be exceeded at any time. Before pulling any cable into conduits, the Contractor shall first consult with the Engineer as to methods and locations of cable pulling.

E. Personnel shall be stationed between the reel and the conduit entrance during pulling operations to inspect control and direct the passage of cable. The conduit mouth shall be equipped with conduit shields to prevent chafing of the cable.

F. Cables shall be lubricated with an approved material in accordance with the manufacturer's recommendation which shall be placed onto the cable during the pulling operation.

G. Cables shall not be allowed to chafe on the ground, handhole edges, or any sharp surfaces during pulling. Flexible cable pulling tubes shall be provided to guide and protect the cable, where necessary.

H. All cut ends of the cable shall have a watertight seal installed immediately after installation, until the cable is spliced or terminated.

I. Cables shall be installed with freedom of horizontal movement to accommodate expansion and contraction of the cables in the conduits. Cables passing through handholes shall have at least one (1) bend to accommodate such changes in length.

3.3 SPECIAL PROTECTION

A. The Contractor shall provide appropriate special protection for cables in areas where the cables are unavoidably exposed to hazardous conditions such as vibration or sharp corners on equipment. The Contractor shall be responsible for replacing, at no additional cost to the Authority, any cable he has installed which is subsequently damaged prior to acceptance as a result of his failure to provide such special protection.

3.4 TESTING

A. General

1. The Contractor shall provide all instruments, materials and labor required for tests specified herein.
2. Tests conducted at the factory shall include, but not be limited to, the following:
   a. Manufacturer's standard tests.
   b. Tests relevant to NEMA WC 7/ICEA S-66-524 standards that are not included in the manufacturer's standard tests. These tests include, but are not limited to, the following:

NEMA 6.4	Test Samples and Specimens for Physical and Aging Tests
NEMA 6.6	Accelerated Water Absorption Tests
NEMA 6.11	Tests for Discharge Resistance
NEMA 6.12	Volume Resistivity
NEMA 6.14	Voltage Tests
NEMA 6.15	Insulation Resistance

3. Tests and checkouts in the field shall include, but not be limited to, the following:

   Dielectric Test
   Continuity Test
   Insulation Resistance Test
   Phasing Test

4. All high voltage cable testing (i.e. primary side) to be completed by respective power company.

B. Conditions for Tests

1. Prior to performing any cable testing, the following conditions shall be fulfilled by the Contractor:
   a. Contractor shall have submitted cable testing procedures for the Engineer's approval at least 45 days in advance of the testing. No testing shall be performed unless the Contractor has the approved test procedures in hand.
   b. For factory tests, a minimum of four weeks advance notification shall be given to the Engineer on the schedule date of tests to enable him to witness the tests. Field tests shall be scheduled in consultation with the Engineer.

C. Witness Tests

1. The Engineer, at his option, shall witness complete testing on all cable installation.

D. Field Tests

1. General. All AC power cables shall be subjected to Acceptance Tests as specified below to ascertain that the dielectric strength of the cable insulation has not been impaired during installation, that the splices and termination are properly made and to confirm the integrity of the cable system prior to energization. Tests shall include continuity tests and insulation resistance tests.
2. Acceptance Tests. After installation of the entire length of a cable, the Contractor shall perform the tests listed below on each cable. To preclude damage to equipment and devices, the tests shall be conducted before the cable is terminated at the electrical equipment. If terminations have already been

made, cables shall be disconnected from the equipment for testing and shall be reconnected after completion of tests.

a. Dielectric Test
   1. This test shall be performed to ensure that the cable insulation has not been impaired during installation.

b. Continuity Test
   1. This test shall be performed to prove the continuity of the conductor.

c. Insulation Resistance Test
   1. This test shall be performed to determine the cable insulation resistance to ground.
   2. Tests shall be conducted with a motor-driven megger. Test voltage shall be applied between the conductor and ground and shall be held until the reading reaches a constant value for five minutes. Insulation resistance values obtained by the megger tests shall not be less than two megohms. Contractor shall bring to the attention of the Engineer the results of similar tests having unequal readings with the variations of 25 percent or more.
   3. For each test, the Contractor shall record the temperature, humidity, and duration of the test.

3. Defective Cables
   a. Any cable installed under this Contract found defective during the testing shall be replaced with new cables at the expense of the Contractor.

E. A record of all approved tests shall be forwarded to the Engineer.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

A. Separate measurement and payment will not be made for work required under the Section, but all costs in connection therefore shall be included in the Contract Lump Sum Price for the items of work to which they pertain.

END OF SECTION

SECTION 16742

VARIABLE MESSAGE SIGN SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. This Section specifies designing, furnishing and installing all of the equipment necessary to form a complete and operational Variable Message Sign (VMS) System. Railroad passenger information shall be displayed via Light Emitting Diode (LED) scrolling Variable Message Signs located on the South Acton Station platform area and drop off area as specified herein and as indicated on the Contract Drawings.

B. The Variable Message Signs shall be controlled from the MBTA Railroad Passenger Information (RPI) System; the train information will be transmitted to the office, and then processed (via predictive algorithm) for train location against schedule and transmitted back out to the stations via the cellular network, providing data to update the messages on the Variable Message Signs. The Contractor shall coordinate the installation, operation and testing of the Variable Message Sign System with GE Transportation Systems; the developer of the MBTA's Systemwide Commuter Rail Passenger Information System.

C. At each Variable Message Sign location provide and install an all weather, two-way (woofer and tweeter) loudspeaker for audio announcements corresponding to the visual message displayed on the Variable Message Sign. Provide all associated audio amplification equipment and loudspeaker distribution cabling for this function.

D. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

E. Related Work: The equipment, materials and methods required under this Section shall be in accordance with the following:

1. Section 01300 – Submittals
2. Section 01400 – Quality Assurance
3. Section 16050 – Basic Materials and Methods for Electrical Work

1.2 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 01300, Submittals.

B. The Contractor shall submit the following to the Engineer for approval:

1. Manufacturer cut-sheets and functional descriptions for all Variable Message Sign System equipment that the Contractor proposes to furnish.
2. Site specific plans showing details of each Variable Message Sign enclosure location and mounting, cable and conduit routing, and sign display orientation.
3. Location of Variable Message Signs as described herein.

4. Point to point wiring diagrams for all equipment furnished under this Section.

5. Two maintenance manuals for the Variable Message Signs and all equipment associated with the Variable Message Sign System.

6. Detailed Test Plans and Procedures, Test Report Forms and completed Test Results.

1.3 QUALITY ASSURANCE

A. All equipment and materials provided shall conform to the requirements of Section 01400 – Quality Control and other applicable references as stated within this Specification.

B. All materials and equipment shall be new, free from any defects, and suitable for the space provided and shall be approved by UL wherever standards have been established by that agency.

C. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

D. All electrical components, unless otherwise specified herein, shall be rated to operate at power, voltage and current levels twenty percent above that level which the components will be subject to in normal service.

E. All components, unless otherwise specified herein, shall be rated in accordance with Recommended Environmental Requirements described in AREMA Manual 11.5.1.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store equipment indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water corrosive substances, and physical damage.

B. If stored in areas subjected to weather, cover devices to provide protection from weather, dirt, dust, corrosive substances and physical damage. Remove loose packing and flammable material.

C. Any equipment, cables, and material damaged during delivery, storage, handling and construction shall be replaced with identical material, tested, and placed in service by the Contractor in accordance with these Specifications and as approved by the Engineer at no additional cost to the Contract.

1.5 COORDINATION

A. Verify that Variable Message Signs are not obstructed by other station signage, structures and architectural elements; and that they do not obstruct other signage.

B. Coordinate the installation, operation and testing of the Variable Message Sign System with GE Transportation Systems.

C. Coordinate the final installation and testing of the Variable Message Sign System with the MBTA and the operating railroad.

PART 2 – PRODUCTS

2.1 VARIABLE MESSAGE SIGNS

A. The Variable Message Signs to be furnished under this Contract shall be Light Emitting Diode (LED) type scrolling message signs. The LED VMS signs shall be Adaptive ALPHA Eclipse 2500 Series Sign, or approved equal, and shall meet or exceed the following specifications:

1. Shall be a single sided display type VMS's mounted back to back at the platform locations shown on the on the Contract Drawings.
2. Shall be a single sided display type VMS, facing the passenger arriving area, shall be installed in the Drop Off Area
3. Shall have a balanced communications interface to receive new program and update data via standard RS-232 and 485 serial interfaces. Data transmitted shall conform to the ASCII character set standard.
4. Be furnished with a software addressable interface that may be set to one of 255 addresses.
5. Shall be fully compatible and interoperable with the existing ALPHA® communications protocol.
6. Shall be powered from an internal power supply and shall utilize a nominal input voltage of 120 Volts AC, 60Hz.
7. The LED display color shall be Amber and shall be readable in direct sunlight.
8. The LED pixel pitch shall be .45 inch per single LED.
9. The LED display viewability shall be 45°.
10. The Variable Message Sign and Sign System shall meet the requirements of the Americans with Disabilities Act (ADA).
11. The Variable Message Sign shall be a full matrix type with a display area composed of 128 LED pixels horizontally and 16 LED pixels vertically. Each LED shall have a minimum life expectancy of 100,000 hours.
12. Typical sign weight including case shall be 100 pounds.

B. The Variable Message Sign logic and the minimum message presentation features shall be as follows:

1. Messages shall travel across the display screen from right to left or left to right.
2. Fixed messages shall display continuously or until the next message is initiated.
3. Shall be able to store at least 80 messages of at least 100 characters each.
4. Message memory shall be battery protected Random Access Memory (RAM) with a minimum capacity of 1 Mb.
5. The VMS character set shall include the international character set of the following fonts and display formats: block (sans serif), decorative (serif), selectable upper and lower case characters; slim, wide and double wide character displays; and programmable character sets.
6. The Variable Message Sign shall be able to display graphic and animated images.

C. VMS Environmental and PC Board Fabrication Requirements

1. The Variable Message Sign and components shall operate at full performance while exposed to temperatures ranging from -40 degrees F to +120 degrees F.

2. The Variable Message Sign printed circuit boards shall be treated with a conformal coating.

2.2 VARIABLE MESSAGE SIGN ENCLOSURE

A. The Variable Message Sign Enclosures to be furnished and installed under this Contract shall meet or exceed the following requirements:

1. Shall be weather-tight, rated NEMA Type 3R and fabricated of aluminum.

2. The VMS Enclosure shall be of a typical dimension of 64" long, 13" high and 8" deep. Access to the data and power connections shall be at the rear of the sign.

3. The VMS Sign front face LED lens cover shall be fabricated of a scratch resistant polycarbonate material.

4. The Contractor shall furnish LED lens cover care and cleaning instructions for the lens cover provided.

2.3 VARIABLE MESSAGE SIGN SYSTEM COMMUNICATIONS AND CONTROL EQUIPMENT

A. The Variable Message Sign System communications and control equipment shall be rack mounted on a 19" equipment rack housed in the South Acton Station Communication Room shown on the Contract Drawings. The Contractor shall furnish and install all necessary cabling, wiring and components to make this a fully functional Variable Message Sign System for simultaneous visual display and audio presentation of MBTA Railroad Passenger Information. The following Variable Message Sign System communications and control equipment or equivalent products shall be furnished, installed, tested and placed into service:

1. 8-Port Serial Device Server – Provide one (1) Serial Device Server to control up to eight signs. The Serial Device Server shall be DIN rail mountable. The Serial Device Server shall be an 8-port rack mount serial device server, shall include both RS-232 and RS-485 signaling and shall include DB9 male connectors for the serial connections. The Serial Device Server shall be a The Moxa Technologies Model NPort 5650-8-DT, or approved equal.

2. 24 Volt Power Supply – Furnish and install one (1) 24 volt power supply to power the Wireless Cellular Modem and Serial Device Server. The 24 volt power supplies shall be DIN rail mountable, Moxa Technologies Model DR-4524 Power Supply, 24/48 VDC, 45 watts with universal 84 to 264 VAC input; or an approved equal.

3. Wireless Cellular Modem – Furnish and install one (1) wireless modem to provide communications between the serial device server and the MBTA main servers. The wireless modem shall be a Blue Tree Wireless Data, Inc., Model BT-6600 Mobile Data Unit, or an approved equal.

4. Wireless Antenna – Furnish and install one (1) Wireless Antenna for connection to the Wireless Cellular Modem. The wireless antenna shall match the frequencies utilized by the cellular service provider and Wireless Cellular Router and shall be installed with a ground plane. The Wireless Antenna shall be an AP8500/18000 Dual Band Cellular/PCS as manufactured by AntennaPlus; or approved equal.

5. Fiber Optic Mini Modem – Furnish and install Fiber Optic Mini Modems to allow for fiber optic communications between the Serial Device Servers and the Variable Message Signs. The Fiber Optic Mini Modems shall be designed to operate over 50/125μ multimode fiber optic cable. The modems shall be Async Fiber Optic Mini Modem ME 605a as manufactured by Black Box; or an approved equal.

6. Uninterruptible Power Supply - Furnish and install (1) rack-mountable uninterruptible power supply sized appropriately to provide a minimum of 30 minutes of run time for the wireless cellular modem, serial device server and fiber optic mini modems in the event of power failure. The UPS shall be APC brand or approved equal.

7. Diagnostic Laptop Terminal – Provide one (1) ruggedized laptop computer for performing field diagnostics, service and troubleshooting the Variable Message Sign System. The laptop shall be equipped with the latest Windows based operating system and any diagnostic software from GE Transportation Systems required for VMS and Railroad Passenger Information System testing and debugging. The laptop shall have the latest hardware configuration at the time of procurement including the highest available Intel processor speed, highest available system memory, 160GB Solid State Drive Flash Module, CD ROM drive, 14.0" diagonal High-Definition LED Display (1366 x 768), Ethernet Card, Wireless Card with Bluetooth, appropriate I/O ports to perform all necessary service functions. A rugged Laptop Terminal case shall be included. The Diagnostic Laptop Terminal shall be Panasonic Toughbook brand or approved equal.

2.4 EQUIPMENT FOR AUDIO ANUNCIATION OF VMS MESSAGES

A. General: At each Variable Message Sign location provide and install a two-way all weather loudspeaker for audio announcements corresponding to the message displayed on the VMS. The loudspeakers shall be connected to an audio amplifier in the South Acton Station Communications Room. The line level audio input to the amplifier shall be from an existing proprietary Text to Audio Message Converter provided by the operating railroad/MBTA.

B. Audio Amplifier Specifications

1.	Audio Inputs	Two (2) balanced inputs for 2-zone system
2.	Frequency Response	70 Hz to 19 kHz (±1 dB)
3.	THD	< 0.5%
4.	Output Power	Dual 80 Watt power amplifiers for 2-zone system, minimum
5.	Output Type	70V and 100V constant-voltage outputs and 4-ohm outputs
6.	AC Power	120V 60 Hz
7.	Operating Temperature	0°C to 40°C
8.	Volume Controls	One for each channel
9.	Tone Controls	Base and Treble for Each Channel

C. Loudspeaker Specifications

1.	Frequency Response	65 Hz to 16 kHz (±4 dB)
2.	Loudspeaker Type	8-inch two-way type, color black
3.	Power Handling	100 Watts
4.	Horizontal Coverage	90° ± 30, typical
5.	Vertical Coverage	90° ± 30, typical

6. Enclosure Material — All-weather copolymer (ABS or equivalent) with rustproof aluminum or stainless steel grill
7. Transformer Taps — 70V: minimum of three between 75W and 7.5W
8. Operating Temperature — -25°F to +135°F
9. Mounting Hardware: Shall include an adjustable mounting bracket with stainless steel hardware to permit the loudspeaker to be adjusted horizontally and vertically to provide the required audio coverage area
10. The loudspeaker shall be a Klipsch CA-800T, One Systems 108 IM (ETS105/60) or approved equal.

D. Loudspeaker Cable Specifications

1. Conductor: — 1 pair, 12 AWG, 19x25 Stranding, Bare Copper Material
2. Insulation: — PVC
3. Outer Shield: — None
4. Drain Wire: — None
5. Outer Jacket: — PVC (Color Black)
6. Application — Suitable for the application and location for which it is intended

2.5 FIBER OPTIC CABLE

A. Fiber Optic Cable General: Multimode fiber optic cable shall be installed between the Fiber Optic Mini Modems located in the South Acton Station Communications Room and the Fiber Optic Mini Modems located within the Variable Message Signs as shown on the Contract Drawings. A minimum six (6) strand 50/125μ multimode fiber optic cable shall be installed to each sign.

B. Multimode Optical Fiber Specifications

1. The multimode fiber shall meet EIA/TIA-492AAAA-A-1997, "Detail Specification for 50-μm Core Diameter/125-μm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers
2. Core Diameter: 50 ± 3.0 μm
3. Cladding Diameter: 125.0 ± 2.0 μm
4. Core Non-Circularity ≤ 5 %
5. Cladding Non-Circularity: ≤ 1.0 %
6. Core-to-Cladding Concentricity ≤ 1.5 μm
7. Attenuation: ≤ 3.5 dB/km at 850 nm and ≤ 1.5 dB/km at 1300 nm.
8. Attenuation Uniformity: No point discontinuity greater than 0.2 dB at either 850 or 1300 nm.
9. Macrobend Attenuation: The attenuation due to 100 turn of fiber around a 75-± 2 mm diameter mandrel shall not exceed 0.5 dB at 850 or 1300 nm.
10. OFL Bandwidth of ≥ 500 MHz•km @ 850 nm and ≥ 500 MHz•km @ 1300 nm

C. Multimode Fiber Optic Cable and Jacket Construction

1. The multimode fiber optic cable shall be designed for outdoor applications
2. The fiber optic cable jacket shall be PVC, color black.

2.6 EQUIPMENT RACK

A. Communications equipment racks shall be furnished and installed at the station communications room shown on the Contract Drawings.

B. Equipment racks shall be 19" wide floor mounted types with EIA Standard 1¾inch spaced single side drilled mounting holes.

C. The rack support channels shall be of 16 gauge steel (minimum).

D. The rack base shall have a minimum depth of 15" with bolt hole spacing of 12" minimum. Each rack shall be furnished with all hardware for securing it to the floor.

E. Each rack shall be finished in gray enamel.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Variable Message Signs and Loudspeakers

1. The Variable Message Signs shall be installed in the locations as described herein and shown on the Contract Drawing. The sign enclosures shall be mounted in accordance with the manufactures recommendations and approved site specific detail plans submitted by the Contractor.
2. Back to Back Variable Message Sign sets shall be installed on the South Acton Station Platform, one set on the inbound side and one set on the outbound side. A single Variable Message Sign shall be installed in the Drop Off Area. See the Contract Drawings.
3. The Contractor shall install the signs providing a minimum vertical clearance of 6'8" (maximum 10') from the surface of the platform and a minimum horizontal clearance of 8'6" from center line of the nearest track.
4. The Back to Back signs shall be mounted perpendicular to the platform with one facing North and the other facing South.
5. The Contractor shall run the power and fiber optic cables in galvanized rigid galvanized steel conduits to each sign enclosure. The Contractor shall provide all junction boxes, fittings, elbows, connectors, etc. necessary to make a complete installation.
6. The Fiber Optic Mini-Modem for VMS communications shall be installed within the Variable Message Sign at each location.
7. For each Variable Message Sign install a Loudspeaker next to the sign and orient the speaker so as to provide full, uniform audio coverage of the area in front of the VMS.
8. Final location and mounting of the Variable Message Signs and Loudspeakers shall be approved by the Engineer.

B. Cable

1. All conductors shall be identified by color and tag listing its function. All cable routing shall be approved by the Engineer. Wire ways for communications cables shall be provided with a section divider to isolate the data communications cable.
2. Fiber Optic Cable Termination
   a. Fiber Optic Patch Panels
      1) 19" Rack-mount fiber optic patch panels shall be provided and installed for terminating the fiber optic cables in the locations on the contract drawings. The patch panels shall provide

space for storing spare patch cables and documentation of the fiber optic certification tests. Patch panels shall have connector panels with LC-LC couplers. Multimode connector panels shall be provided as required.

2) Stand alone fiber optic patch panels shall be provided and installed as required or as shown on the contract drawings.

3) The Contractor shall provide all mounting hardware and back panels required to properly secure the Patch Panel to a standard rack structure. All fiber cables shall be properly labeled.

3.2 TESTING

A. The Contractor shall notify the Engineer at least five days in advance of the test of the Contractor supplied materials, so that the Engineer or his representative may be present at this test if he so elects. Upon completion of the test, a certified test report shall be submitted to the Engineer.

B. Any system deficiencies observed under testing shall be noted in the certified test report. All deficiencies shall be corrected and system shall be retested. A sequential test report shall be submitted.

C. Factory Testing - The Contractor shall factory test each electronic sign, prior to integration with the mounting assembly. Full functional testing shall be performed.

D. Field Installation Testing – The Contractor shall test each component of the Variable Message Sign System including all communications, control and audio amplification and loudspeaker equipment to ensure that the equipment is properly installed and that all functions and features are operating as specified and intended in the Contract. The Contractor shall submit as-built drawings and maintenance manuals one week prior to final scheduled System Testing.

E. System Testing - The Contractor shall coordinate with the MBTA and GE Transportation Systems for integration of the South Acton Station Railroad Passenger Information system into the MBTA's Systemwide Commuter Rail Passenger Information System. The Contractor shall, with the assistance of the MBTA or their contractor, functionally test the complete system. The Contractor shall provide necessary staffing to correct any deficiencies that are observed with the Contractor's portion of the system during the system testing period. The Contractor shall notify the MBTA 30 days in advance of the system test so that the MBTA can make necessary arrangements for their testing staff.

F. After the completion of all punch list items the Contractor shall provide as built drawings including all changes made during system testing.

PART 4 MEASUREMENT AND PAYMENT

A. MEASUREMENT

1. Payment for each Variable Message Sign will be made at the contract unit price for the Item 1042.170 - VARIABLE MESSAGE SIGN G-1. This shall include the Variable Message Sign, Mounting Posts and Brackets, Loudspeaker and Mounting Bracket, Fiber Optic Cable, Loudspeaker Cable, Power Cabling, Conduit, VMS Fiber Optic Patch Panel, Matching Pair (2) of Fiber Optic Mini Modems, and all connectors wire and consumables to form a complete operating

and tested Variable Message Sign and Loudspeaker installation. Payment shall constitute full compensation for all costs including providing the required submittals, and all materials, equipment, tools and labor necessary to furnish and to install Variable Message Signs to the complete satisfaction of the Engineer.

2. Separate measurement and payment for Variable Message Sign Control System will not be made for work under this section, but all costs therefore shall be included in the Contract Lump Sum price for Item 1042.171 - VARIABLE MESSAGE SIGN G-1. This shall include the Wireless Cellular Modem and Antenna, 8-Port Serial Server, Communication Room Patch Panel, Audio Amplifier, Data Communications Cabling Set for VMS Control System, Line Level Audio Cabling and Equipment Set for interface to MBTA provided Text to Audio Message Converter, Uninterruptible Power Supply, and all required connectors, wire and consumables to form a complete Variable Message Sign Control System.

B. PAYMENT

ITEM NO.	DESCRIPTION	UNIT
1042.170	VARIABLE MESSAGE SIGN G-1	EA
1042.171	VARIABLE MESSAGE SIGN G-1	LS

END OF SECTION

SECTION 16750

ELEVATOR INTERCOM SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies the provisioning of an Elevator Emergency Intercom System. Equipment shall be compatible with the existing Elevator Emergency Intercom Supervisory System located at the Town of Acton's Police Station at xxx _____Street and with the Authority's Police Station and maintenance terminal located at 500 Arborway.

B. The audio path between the Station the Acton Police Station and the MBTA Police Station shall be via Verizon analog Centrex telephone service. A maximum of three Elevator Emergency Intercom units shall be connected to one Centrex telephone circuit.

C. Location of Elevator Emergency Intercom units shall be in the elevator cab as indicated on the contract drawings for station design. Locations shall conform to the Americans with Disabilities Act (A.D.A.) standards.

D. The Contractor shall be responsible for programming each unit and updating the software/database on each supervisory and maintenance computer.

E. Major components of the Elevator Emergency Intercom System shall include, but not be limited to, the following equipment as shown on the Contract Drawings:

1. Elevator Emergency Intercom Units.
2. Uninterruptible Power Supplies.
3. AC/DC power converters.
4. Wiring and cables.
5. Mounting hardware, conduit, connectors, and any other miscellaneous hardware.

1.2 REFERENCES

A. Americans with Disabilities Act (ADA)

B. National Electric Code

C. EIA / TIA

D. IEEE

E. Architectural Access Board

1.3 SUBMITTALS

A. Submit descriptive literature, including manufacturer specification sheets, for all Passenger Assistance equipment and materials proposed for approval prior to fabrication, assembly, installation and testing. Also, submit the following to the Engineer for approval:

1. Block diagram of complete system, illustrating proposed configuration and interconnections.

B. Prior to ordering any equipment required under this Section, submit six (6) copies of the following to the Engineer for approval:

1. Full technical data and manufacturer cut sheets for all equipment.

2. Site specific plans showing details of the following:

a. Elevator Emergency Intercom unit location and mounting details.

b. Cable and conduit details.

c. Communication room equipment layout.

C. Provide maintenance instruction manuals to the Engineer including information regarding installation and maintenance as follows:

1. Operational Description and Procedures

2. Troubleshooting and Routine Test Procedures

3. Adjustments and Alignment Procedures

4. Wiring Diagrams, Tables and Schematics

D. Hold Point

1. Prior to installing any equipment, submit to the Engineer for approval six (6) copies of a detailed test procedure intended to ensure all components of the system are functioning properly, in accordance with these Specifications and the Contract Drawings. The tests performed shall include, but not be limited to, the tests outlined in Paragraph 3.02 of this Section. The detailed test procedure shall include a description of all test equipment to be used, and specific pass/fail criteria for each test.

1.4 DELIVERY, STORAGE, AND HANDLING

A. The Contractor is responsible for the delivery, storage, and handling of all materials for the Elevator Intercom System. Items shall be stored in a safe and secure location. All electronic components shall be protected from water, dust, etc.

1.5 WARRANTY

B. The Contractor shall provide a one-year warranty on parts and labor commencing on the day that the Emergency Elevator Intercom System is accepted by the MBTA Communications Department.

PART 2 - PRODUCTS

2.1 MATERIAL

A. All material shall be new and unused and the workmanship shall be in accordance with the highest standards of the electronic equipment industry. Bids will be accepted only for new and current equipment. Equipment discontinued by the manufacturer will not be accepted. All components shall be UL listed.

B. Equipment purchased under this Section shall be covered by EIA/TIA standards and the manufacturer's warranties against material and workmanship commencing from the date the Authority accepts the Elevator Emergency Intercom System for the period noted on the manufacturer's warranty or for a minimum of one (1) year, whichever is greater.

C. Provide all equipment capable of operating within a transit system environment, subject to temperature, humidity, vibration, and light conditions typically encountered.

2.02 ELEVATOR EMERGENCY INTERCOM UNITS

A. Elevator Emergency Intercom Units provided under this Section shall meet the following requirements:

1. The Elevator Emergency Intercom Unit shall be a microprocessor based, programmable, flush mount, no handset, full-duplex speaker telephone with a front panel of stainless steel. Depressing the call button shall activate the Elevator Emergency Intercom Unit. The emergency button shall have a diameter of ¾ inch or greater. The button will have no moving parts to jam or seize. The front panel shall be sealed and impervious to water, dust, and spray. The speaker and microphone shall be protected from vandalism by mesh screens. The internal electronics shall be encapsulated with a military specified protective coating to protect against moisture and dust accumulation.

2. The Elevator Emergency Intercom Unit shall be fully ADA. compliant as specified in ADAAG 4.10.14 and ASME 17.1. Two LED indicators shall be incorporated in the front panel, one to show that a call has been placed, and the other to indicate that it has been answered. The Elevator Emergency Intercom Unit shall incorporate stainless steel raised lettering and grade 2 Braille to aid the sight impaired persons in identification. The Elevator Emergency Intercom Unit shall have the ability to record and play voice messages stating the location of the unit.

3. The Elevator Emergency Intercom Unit shall be programmable from any touch tone telephone (including security codes) and shall have four telephone number (zero to twenty digits, including pause) auto dial capability, in addition to a

programmable maintenance number. The Elevator Emergency Intercom Unit shall employ call progress monitoring to detect whether a call has been successfully placed in order to ensure timely call completion. The Elevator Emergency Intercom Unit shall have the option to automatically respond to far end call termination signals. When the receiving agent hangs up the Elevator Emergency Intercom Unit shall automatically place itself back on hook. The Elevator Emergency Intercom Unit shall have an automatic number identifier. The Elevator Emergency Intercom Unit shall have auxiliary output contacts that may be remotely or locally activated.

4. The Elevator Emergency Intercom Unit shall have the capability to store a voice message. The message shall be played after the emergency button call is answered.

5. The Elevator Emergency Intercom Unit shall be powered from 5 to 24 VDC and shall be provided with a 120 VAC adapter. A rechargeable Nickle-Cadnium backup battery capable of operating the Elevator Emergency Intercom Unit for four hours shall be provided. The battery shall be trickle charged from the input power source. The Elevator Emergency Intercom Unit shall utilize a backup battery warning call feature. If the source of power is interrupted and the unit is on battery for fifteen minutes, the unit shall place a warning call. The unit shall automatically go off-hook and dial a separate maintenance number, wait for an answer and then notify the call party (i.e., by audio tones.).

6. The Elevator Emergency Intercom Unit shall be compatible with all features of the existing Vandal-Proof Products PR1150 supervisory system employed by the Authority. This system provides remote supervision, event logging, reports, and diagnose functions.

7. The Elevator Emergency Intercom Unit shall be mounted to the cab with a minimum of six tamper proof screws. The screws shall be alike those already utilized at the Authority. The Contractor shall provide four tamper proof screwdriver hex shank bits.

8. The Elevator Emergency Intercom Unit shall communicate via a Verizon Centrex dial tone. A maximum of three units shall be connected to a single Centrex telephone circuit. Each unit shall be accessed separately on the same telephone circuit via password codes. The Contractor shall be responsible for all wiring and connections. The Elevator Emergency Telephone shall be a model VPP1250 or approved equal.

9. The Contractor shall be responsible for updating all databases/software utilized in conjunction with the Elevator Emergency Intercom Unit system.

B. Mechanical Specifications

1. Faceplate Dimensions: 12" x 8" x 2.5" (" 0.5 ").

2. Front Panel: 12 gauge, 304 stainless steel. Minimum six mounting holes. Screws to be tamper resistant, as approved by the Authority

3. Connector: 2 auxiliary outputs, 1 RJ-11, 1 Power.

4. Weight: approximately 5-7 pounds.

5. Operating Temperature: -20° C to +60° C.

C. Electrical Specifications

1. Telephone connection: RJ-11 modular jack.

2. Max Loop Resistance: 1500 Ohms (loop start operation).

3. Power: 5.5 to 25 VDC or derived from 110 VAC (power transformer to be provided). For multiple unit installations, provide a bulk power supply to power all units.

4. REN: 1.1.

5. Signaling: tone or pulse.

6. Frequency Response: 300Hz to 3,000Hz.

7. FCC registered.

8. Outputs: Optically isolated, solid state, normally open contacts. Maximum DC resistance drop of 35 ohms at a current of 120 milliamperes.

9. Voice Message Length: minimum of 18 seconds

2.03 WIRE AND CABLE

A. Provide four pair unshielded twisted pair communication cable from the station telephone terminal board to each elevator machine room. Provide connections from the elevator machine room terminal block to the elevator travel cable to the Elevator Emergency Intercom Unit.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install Elevator Emergency Intercom Units in locations with the orientations as approved on the contract drawings.

B. Install supporting equipment in cabinets and on racks, in the station communication room as shown on the contract drawings.

C. Provide required software modifications to the existing supervisory software at the MBTA police headquarters (240 Southampton Street), and all additional monitoring locations.

3.02 TESTING

A. Conduct electrical tests to demonstrate compliance with this Specification and with

manufacturer's recommended test procedures as approved by the Engineer.

B. After installation is complete, verify proper operation of all control as described herein. Notify the Engineer minimum of five days in advance of test. Engineer or authorized representative reserves the right to attend testing.

PART 4 - MEASUREMENT AND PAYMENT

4.01 GENERAL

A. Portions of the intercom system integral to the elevator assembly shall be measured and paid for as part of the lump sum price for Elevators in accordance with Section 14200 Hydraulic Elevators.

B. Portions of the intercom system integral to the Hub Center shall be measured and paid for as part of the Hub Center in accordance with Section 13138 Hub Facility.

C. Conduit, wire and pull boxes for the intercom system shall be measured and paid for in accordance with Section 16050 Basic Materials and Methods for Electrical Work.

D. The balance of the intercom system shall be measure for payment as part of the lump sum price for item 1651.000, Telephone Equipment.

END OF SECTION

SECTION 16840

CLOSED CIRCUIT TELEVISION SYSTEM

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

A. This Section specifies the requirements for the Closed Circuit Television System (CCTV System). This section specifies the functional design requirements and installation requirements for an IP camera based video surveillance system with digital network recording with equipment at designated locations, as shown on the contract drawings, including CCTV cameras inside elevator cabs and elevator landings.

B. The CCTV System will use the new Transmission Network System infrastructure to carry Ethernet IP Video from the cameras along the Fitchburg Line to the Network Video Recorder (NVR) located at the CROCC.

C. The CCTV System Ethernet network shall be an extension of the existing MBTA AFC Video Network. The CCTV System Ethernet network and existing MBTA AFC Video Network shall be connected at the CROCC and shall be a separate Ethernet network over the Transmission Network System.

D. The current MBTA CCTV system consists of a Visual Defence (VDI) Virtual Matrix Software (VMS) application which allows MBTA personnel to access live and recorded video streams from any camera, encoder or DVR/NVR on the system. The VDI VMS Soft Client and Soft Monitor applications are currently installed on multiple computer workstations within the six (6) Hub Centers, Operations Control Center (OCC) and many individual computer workstations throughout the MBTA network. All modifications or additions to the system which require software, firmware, device codec, device drivers or any other modifications to support new and existing equipment provided and specified within this Contract, the Contractor shall upgraded all existing installations to allow users access to the equipment provided under this Contract.

E. The contract includes furnishing and installing a new Network Video recorder (NVR) at the location on the contract drawings. The NVR shall record all Fitchburg line video feeds, unless otherwise specified. The NVR shall also have the capability to transmit live and recorded video over the MBTA WAN. The Contractor shall work with MBTA IT department to configure the CCTV System Ethernet switches to allow recording video traffic to pass only to the ports assigned for the NVR. Video recording streams from IP Cameras shall not be allowed to pass through the station switch on to the MBTA WAN. Only Video Streams from the NVR to viewing Clients shall be permitted to pass over the MBTA WAN.

F. The contract includes the software modifications of the VDI application server located at 45 High Street 2nd floor. This server shall monitor the status of all existing and new CCTV system components and act as a central repository for all system information.

G. Improvements and modification on the VDI video system may involve multiple contractors. It is a requirement of this contract to work with all parties to ensure no impact to the MBTA videos system. The Contractor working on the system shall properly schedule their work as to not impact the other contracts. The Contractor working on the system is required to make a backup of the system software prior to making any changes/alterations/improvements to the system and is required to make a backup

of the software after completing any changes/alterations/improvements to the system. The Contractor shall make the MBTA aware, prior to any work performed on the system or of any system modifications could impact other system improvements. The system backup and backup equipment shall be left onsite for the duration of the project. Each backup shall be labeled, as a minimum, with the following: Contractor name, MBTA project name, MBTA contract number, date of backup and description of the backup.

H. The Contractor shall provide all configuration/setup/programming of new and existing video systems components, identified in this specification section for a complete working system.

I. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
1. 16749 – FIBER OPTIC CABLE
2. 16720 – TELEPHONE SYSTEM
3. 16780 – RADIO SYSTEMS
4. 16740 – TRANSMISSION NETWORK SYSTEM
5. 6742 – VARIABLE MESSAGE SIGN SYSTEM
6. 16826 – COMMUNICATIONS CABLE ROUTING SYSTEMS
7. 16897 – MISCELLANEOUS COMMUNICATIONS EQUIPMENT
8. 16898 – COMMUNICATIONS SYSTEMS TESTING
9. 16910 – TECHNICAL MANUALS
10. 16900 – TRAINING PROGRAM

1.2 MATERIALS/EQUIPMENT

A. All equipment shall be new, corrosion resistant and in strict accordance with the details shown on the plans and in the specifications.

1.3 QUALITY ASSURANCE

A. Submit proposed manufacturer of telephone instruments and ancillary equipment to the Engineer for approval. All equipment shall be new and unused. Past performance and experience will be factored in evaluating each proposed manufacturer, in part. Additional criteria will be:
1. Quality and capability of equipment.
2. Manufacturer Support.
3. Technology used system flexibility, and features.
4. Ability to furnish and install within required time frame.

B. Manufacturer shall provide a one year warranty on all equipment furnished and installed. Contractor shall maintain this warranty, extending to system acceptance or one year after equipment is placed into service, whichever is later.

C. Manufacturer of equipment shall be in compliance with a quality assurance program that meets intent of ASQC Standard Cl 1968; General Requirements for a Quality Assurance Program. Compliance shall promote thoroughly tested equipment that will render long service life. Manufacturer shall focus prime concern on necessary formal assurance requirements to ensure equipment failure cannot be attributable to actions or lack of actions.

1.4 SUBMITTALS

A. Prior to approval of the CCTV system hardware and software components, the Contractor shall submit the proposed equipment vendors qualifications and a written statement from the vendors

acknowledging that the hardware and software to be supplied shall meet all functionality as required within this specification. The Contractor shall submit a typical site block diagram indicating hardware and software components that shall be installed at all locations.

B. The Contractor and vendor shall be prepared to demonstrate the equipment functionality within two weeks of submission and prior to vendor/equipment approval. The contract shall plan to demonstrate how this proposed equipment meets or exceeds all functional/performance requirements of the proposed vendor solution.

C. Submit descriptive literature, including manufacturer specification sheets, for all CCTV equipment and software functionality and materials proposed for use in accordance with the requirements of this Section for approval prior to fabrication, assembly, installation and testing.

D. Also, submit the following to the Engineer for approval: Block diagram of complete system, illustrating proposed configuration and interconnections.

E. Prior to ordering any equipment as required under this Section, submit six (6) copies of the following to the Engineer for approval:

1. Full technical data and manufacturer cut sheets for all equipment.
2. Site specific plans showing details of the following:
   a. Camera and enclosure location and mounting details.
   b. Cable and conduit details.
   c. Light intensity ranges throughout the surveillance areas (determined by actual field tests).
   d. Camera field of vision.
3. Submit schematic and wiring diagrams complete with terminal numbers.
4. Submit NVR storage recording calculations, in days and hours, based on motion sensing configuration. Define camera image motion zones and activity levels.
5. Submit procedures for programming and troubleshooting.
6. Submit full interconnect diagram for overall system, including interface connections to existing equipment.
7. Submit configuration plan for camera/NVR access levels.

F. Supply maintenance instruction manuals to the Engineer including information regarding installation and maintenance as follows:

1. Operational Description and Procedures
2. Troubleshooting and Routine Test Procedures
3. Adjustments and Alignment Procedures
4. Wiring Diagrams, Tables and Schematics

G. Prior to installing any equipment, submit to the Engineer for approval six (6) copies of a detailed test procedure intended to ensure all components of the system are functioning properly, in accordance with these Specifications and the Contract Drawings. The tests performed shall include the tests outlined in Paragraph 3.3 of this Section. The detailed test procedure shall include a description of all test equipment to be used and specific measurements and/or pass/fail criteria for each test.

H. Factory Tests: Submit at completion of factory testing, including program software, six certified copies of test results.

I. Test Procedures and Reports: Full details shall be submitted of the scheduled tests and the expected duration of all test procedures. Samples of all test report forms, and full details of the methods that the raw test data is to be reduced, shall be approved before commencement of system testing to be furnished under this Contract.

1. The test report shall identify the name of manufacturer, model numbers, serial numbers, and the last date of calibration of test instrumentation. Documentation shall be furnished to verify that test instruments have been calibrated not more than nine months prior to the tests. If a test instrument does not require calibration, it shall be highlighted in the report.
2. The test report shall include a list of attendees.
3. Certified test results for the system components tests shall be submitted within 30 days after the completion of each test. No equipment shall be released for shipment until certified test data is approved by the Authority. Copies of approved test procedures, raw data measured results, calculations and all data derived from tests shall be included as part of report. All test data shall be bound in one report. The test report shall be indexed and cross-referenced in an easily understood manner.

J. Certificate of Compliance: Submit a certificate of compliance that all components furnished meet the requirements specified herein.

K. Operation and Maintenance Manuals shall be submitted as listed below:

1. The Contractor shall furnish an operation and maintenance manual for each piece of equipment, unless otherwise specified herein. The manual shall be provided in both hardcopy and on compact disk. The MBTA Communications Department prior to submittal shall approve the software utilized. The following identification shall be inscribed on the cover: the words "OPERATING AND MAINTENANCE MANUAL", the name and location of the project, the name of the Contractor, and the contract number. The manual shall include the names, addresses, and telephone numbers of each subcontractor furnishing or installing equipment. In addition, include the local representatives for each item of equipment. The manual shall have a table of contents and index. The manual shall be assembled to conform to the table of contents, including tab sheets placed before instructions covering the subject. The instruction sheets shall be legible with large sheets of drawings folded in. The contents of the manual shall also be available online by means of a help screens.
2. The Contractor shall submit to the Engineer for approval three copies of the preliminary operation and maintenance manual at least 30 days prior to shipment of first relevant unit. After approval of the preliminary submittal and having made all necessary corrections and amendments as required, the Contractor shall supply the Engineer with six additional copies of the approved dated operation and maintenance manuals. One set of master camera ready copy shall be included as one of the six copies to permit additional copies to be made. The master camera ready copy shall be clearly marked as such on the outside. One manual shall be provided on compact disk. The MBTA Communications Department prior to submittal shall approve the software utilized. The manual shall provide a clear explanation of the theory, operation, and maintenance of the equipment accompanied by photos and schematic, wiring and mechanical assembly diagrams, as required. The manual shall be indexed and cross-referenced in an easily understood manner. The manual shall be loose leaf bound and shall include the following information:
   a. Operating instructions.
   b. Troubleshooting and fault isolation procedures for onsite level repair.
   c. System equipment removal and replacement procedures.
   d. A list of the replaceable components.
   e. A test procedure to verify the adequacy of repair work.
   f. A preventive maintenance schedule and instructions for the replacement of any electrical equipment.
   g. A preventive maintenance schedule for inspection, removal, and replacement for each component.
   h. A list of special tools provided by the manufacturer.

i. A list of recommended tools and test equipment as required performing all maintenance tasks.
j. Recommended spare parts list for one year's operation.
k. Interchangeable parts list showing parts common to items of equipment.
l. Equipment manufacturers' descriptive literature including catalog cuts.
m. As built working drawings.
n. System component approved factory test reports.
o. The latest service bulletins with dates that describe service procedures.
p. Video encoder configuration, troubleshooting, fault diagnostics and default settings.
q. The NVR software programming, troubleshooting, fault diagnostics and shutdown procedures.
r. Full Operations Manual for CCTV system software.

1.5 REGULATORY REQUIREMENTS

A.

1. Comply with all applicable requirements of the following:
a. National Electrical Code
b. Massachusetts Electrical Code
c. EIA/TIA
d. IEEE

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Furnish all items of the material, design, sizes and ratings shown on the Contract Drawings and specified herein.

2.2 MANUFACTURER/CONTRACTOR EXPERIENCE

A. Refer to Section 01010 SUMMARY OF THE WORK.

2.3 MATERIAL

A. All material shall be new and unused and the workmanship shall be in accordance with the highest standards of the electronic equipment industry. Bids will be accepted only for new and current equipment. Equipment discontinued by the manufacturer shall not be accepted. All components shall be UL listed.

B. Equipment purchased under this Section shall comply with applicable EIA standards and the manufacturer's warranties against material and workmanship.

C. Supply all equipment capable of meeting the performance requirements within the MBTA transit system environment, subject to temperature, electromagnetic interference, humidity, vibration, and light conditions typically encountered.

2.4 VDI CCTV SOFTWARE – HUB CENTER DIGITAL VIDEO SYSTEM

A. The VDI CCTV System software has the functionality to view, control and record MPEG4 IP video streams from over 2500 cameras, 2500 video encoder channels, and 150 locations with over 150

digital video recording systems. This shall not result in any additional software licenses as required to view, control and record video feeds installed under this system.

B. The VDI CCTV system shall be programmed and configured to view live video streams for all the new cameras added to the system. This shall include the configuration and setup of all sub assemblies including DVRS and Encoders.

C. The VDI CCTV System shall be programmed and configured to view/search recorded video streams for all the new cameras added to the system. This shall include the configuration and setup of all sub assemblies including DVRS and Encoders.

D. Upgrade VDI software to include latest version of software and OPC interface exact language to be added based on VDI comments.

4.1 IP CCTV CAMERA

A. General Functional Requirements:

1. The camera shall be an IP type CCTV camera to produce detailed images for recording on a Network Video Recorder (NVR).
2. The camera shall be fully compatible with the NVR upon which its images shall be recorded and the NVR shall be fully compatible with the existing Visual Defence CCTV management system.
3. The camera shall be housed in a vandal resistant, environmentally conditioned housing, suitable for outdoor use in the Boston, MA area.
4. The camera assembly shall include pan and tilt manual camera positioning.
5. The camera shall employ a C/CS Lens Mount.
6. The camera assembly shall employ varifocal lenses to permit optimal zoom adjustments.
7. The Contractor shall select and adjust the varifocal lens to provide the best field of view for each camera, as determined by representatives of the MBTA viewing actual video images.
8. The Contractor shall supply and install all required camera mounting brackets, adapters, and associated hardware to mount the IP CCTV Cameras and associated lens at the locations shown on the Site Plans.
9. Cameras used inside elevator cab shall be wide angle, ceiling mounted and shall provide full view of the elevator cab interior.
10. Cameras shall have automatic adjustment to light level variations from 3 lux to full lighting within the cab.
11. Cameras shall be connected using elevator traveling cables.

B. Technical Requirements:
(BEING DEVELOPED)

2.5 NETWORK VIDEO RECORDER

A. The Network Video Recorder (NVR) shall store video from digital video sources in MPEG4, MPEG2, MJPEG, H.264 codec's. The video shall be accessible in near real time, and shall be stored on computer based storage devices for review at a later time.

B. Although the NVR is to be standalone, it shall appear to Operators to be seamlessly integrated with the entire existing CCTV System. All NVRs shall have their time synchronized with Network Time Protocol. The time shall be synchronized with the MBTA public time server and shall update all systems at a minimum of 3 times a day and shall not have an effect on network traffic. The Contractor shall coordinate the time synchronization solution with the MBTA ITD department.

C. The NVR system shall be capable of working with video encoders and IP cameras which produce continuous, motion based and analytics based streaming video. The NVR shall "tag" system and video events to allow for rapid retrieval of video streams by an external software application.

D. The NVR manufacturer shall provide a Software Development Kit (SDK) to allow third party system integrators to gain access to access live and stored video, device control and device status monitoring. Full system functionality shall be available through the SDK. The Manufacturer shall furnish a list of integrated 3rd party applications currently using the API/SDK. The Contractor shall be responsible for all integration efforts required to fully integrate the NVR SDK with the existing Visual Defense head end. As a minimum the NVR API/SDK shall provide the following functionality accessible to 3rd party applications:

1. Create/Modify/Delete system objects
2. Create/Modify/Delete recording parameters including frame rate, resolution, and bit rate
3. Create/Modify/Delete video playbacks to specific client systems
4. Monitor/Access system status parameters including storage and system alarms
5. Bookmark/Tag video recordings
6. Create/Modify/Delete recording storage parameters
7. Frame Rate reduce video playbacks to specific client systems
8. Create/Modify/Delete user security levels
9. Create Video Clip Exports
10. Provide MD5 hash watermark for video authentication
11. Provide the source code or compiled application to decode and render MJPEG, MPEG2, MPEG4, and H.264 video streams
12. Provide playback controls for video streams that include:
    a. Fast Forward (10 steps)
    b. Rewind (10 steps)
    c. Pause
    d. Slow Motion
    e. Advance 30 seconds
    f. Rewind 30 seconds
    g. Real Time Reverse Play
    h. Jump to Beginning
    i. Jump to Live
    j. Manual Event Tag

E. The NVR shall work with the Mata's Visual Defence head end video matrix application. All video components, servers, computers, etc shall work as an entire system.

F. The Contractor shall be responsible for all necessary software upgrades to existing video system management servers.

G. The NVR shall meet or exceed the following capabilities:

1. Digitally, record video at all times and retain video for no less then 30 days.
2. Digitally stream encoded video to remote users connected via the six (6) 10/100/1000MB network ports onto the MBTA's WAN. Streaming video shall be encoded in an industry standard MPEG4 formats; Advanced Simple Profile (ASP) or Simple Profile (SP). "MPEG4based" codec's are not acceptable. The video stream shall be software adjustable in both frame rate and resolution.
3. Digitally record continuous video full time, 24 hours per day, 7 days per week, and 36 days per year, without loss of information.

4. Shall be provided with all licensing necessary to accept 72 network video stream inputs and be capable of recording 30fps and 4CIF resolution on all 72 streams simultaneously without impacting performance.
5. Shall work with IP cameras and mega pixel cameras currently available on the market that meet or exceed the requirements on this specification.
6. Shall work with at least three encoders that meet the video encoder requirements of this specification such as Teleste EASI MPX (8 channel), Nice Vision NVSAT and AXIS video encoders. The version firmware supported on these devices shall be latest version. The Contractor shall be responsible to have the latest version installed.
7. Allow for each video stream to digitally record at different frame rates and different resolution. Each camera input shall have full frame rate (30fps) and QXGA 2048 x 1536 resolution capability.
8. NVR and components shall be capable of Camera Frame Rate Reduction. Camera Frame Rate Reduction shall be defined as high resolution (4CIF or greater) for recording or live streams in addition to simultaneously low resolution video streams.
9. Shall be capable of providing Performance Monitoring. Through Software application the NVR shall report status on all components within the system, including:
   a. High heat conditions
   b. Ethernet link errors
   c. Storage errors
   d. Storage reaching limit
   e. Storage exceeding limit
   f. Recording failures
   g. Power Supply status
   h. RAID status
   i. Mount status
   j. Drive status
   k. Temperature for each drive
   l. Total space
   m. Free space
   n. Reads and writes
   o. Files stored bandwidth use, input and output.
   p. Inbound and outbound streams.
   q. HTTP statistics.
   r. RTSP statistics.
10. The system shall initiate contact closures on 3rd party equipment via HTTP messaging placed on the TCP/IP network. The system shall be able to generate a contact closure on an encoder and display visual and audible alarms, email support teams and store support logs for the following events;
    a. Low, medium, high and critical alarms on the NVR
    b. Loss of video from any source
    c. NVR reset
    d. Loss of time sync
    e. Storage unavailable
11. Support an unlimited number of concurrent users, the vendor shall provide unlimited licensing required for client applications.
12. The system shall not allow for additional costs for licensing per NVR. All license costs shall be included in the NVR price supporting the total number of recording video streams for the NVR.
13. The systems shall allow operators to transfer data for long-term storage, and later retrieval, on removable electronic media such CD, DVD, USB or other electronic media at any authorized workstation.

14. The system shall allow operators to retrieve images based on alarms, time, date, motion, event and camera.
15. The system shall allow for a minimum of 20 concurrent users to retrieve archived images without interfering with the recording or video distribution process or the operations of other users.
16. The system shall allow operators to review of archived images without interfering with the recording or video distribution process.
17. The system shall allow for the archived video to be off loaded to a central storage system without interfering with the recording process. The off loading of video shall be configured to run automatically based upon a predefined schedule.
18. The system shall allow all connected users to view real-time and recorded video from any camera feed. The transition from live to recorded video shall be seamless to the operator.
19. The system shall allow for the operator to view both live and recorded video from multiple cameras simultaneously in the virtual matrix display with individual time controls for each video stream.
20. The system shall provide video authentication to prevent images from being altered.
21. The system shall have all recording to be continuous, scheduled, event and motion based Recording configurations to be set at the administrative level. Motion based recording shall have multiple motion zones per video stream.
22. The system shall allow multilevel password protected functions in all user definable and alterable functions.
23. The system shall allow operators to digitally zoom in during record and playback without negatively affecting the playback of the video.
24. The system shall be designed to allow operators to provide alarm call up on any camera or groups of cameras upon alarm input.
25. The system shall "boot up" and immediately start recording automatically upon switching on power. It shall not be required to login to the system to commence recording.
26. The equipment shall be supplied with all the necessary hardware for rack mounting 19" or 23" brackets where required.
27. The system shall utilize Linux, Real Time Internet Kernel (RTIK), Windows 2000 operating system or higher.
28. The system shall have a Graphical User Interface (GUI) software application for system administration and system configuration and set up.
29. The system shall log all events associated with the recorder. Log events shall be preceded by device identification to differentiate between devices within the system shall include the following:
    a. Status of recorder: power up, power down
    b. Loss of video alarm
    c. Hard disk status indications alarms
    d. Recording enabled/disabled per stream
    e. The system shall be capable of generating reports of all system events.
    f. Remote event notification: The system shall be capable of sending an email notification based upon the change in status of any of the above mentioned events and any other system problem.
30. The system shall provide the ability to select video clips for long-term storage and video export in different file formats MPG, MPG4, AVI, JPEG, H.264 and other common format for all types of encoders connected to the NVR at an authorized workstation.
31. The NVR shall occupy 2U or less of rack space.
32. The NVR shall record all video streams to an external storage unit which shall meet or exceed the following:
    a. The storage unit shall have sufficient bandwidth to record and stream out a minimum of 72 channels of 4CIF 30fps video each way simultaneously.

b. Shall have a three year manufacturer's warrantee starting at the substantial completion date of the project.
c. The RAID 5 storage arrays shall support hot swap drive replacement with all video storage hard drives accessible from the front while the external storage unit is installed in the equipment rack.
d. The RAID 5 arrays shall support automatic drive rebuilding while simultaneously recording video at full capacity and shall generate an alarm in the video system when a drive fails identifying the storage unit as well as the specific hard drive in the array.
e. Minimum storage space shall be 4 TB.
f. Hard disk drives shall be Serial ATA, SAS or approved equal.
g. Minimum drive size is 500GB.
h. Maximum array size is 8 drives.
i. Network interface shall be 10/100/1000MB 10 BaseT Network Connection
j. Shall occupy 4U or less of rack space.

(BEING DEVELOPED)

2.6 ETHERNET SWITCH – ENVIRONMENTALLY HARDENED

A. Furnish, install and configure an Ethernet switch where indicated on the Contract Drawings for the purpose of supporting a field interface to the WAN. To support networking capabilities as well as routing Ethernet data, streaming video and future voice over IP. The Ethernet switch shall meet the following specifications:

1. Copper Port(s): 4 x 10/100BaseT PoE (RJ45)
2. Fiber Port(s): 2 x 100FX Single mode fiber (SC)
3. Console Port(s): 1 x DB9
4. Din Rail or surface mountable
5. Switch Fabric Capacity: Full port speed on all ports
6. MAC Address Entries: 4000
7. Operating Temperature: 40° to 60° Celsius
8. Power Source: Dual 48VDC inputs
9. LAN Standards: IEEE 802.1d Spanning Tree Bridge, IEEE 802.3 CSMA/CD or Ethernet, IEEE 802.3u 100 Mbps (Fast Ethernet), IEEE 802.3ab 1000 Mbps (Gigabit Ethernet), IEEE 802.3ad Link aggregation, IEEE 802.1w Rapid Spanning Tree Protocol (RSTP), IEEE 802.3x Flow Control, IEEE 802.1Q (VLANS), IEEE 802.1p (Priority)
10. Power Over Ethernet (POE) Support
11. Management Protocols: SNMP, RMON, Telnet
12. Protocols: IGMP, RADIUS, SSH, TCP, UDP, DHCP, PIM

(BEING DEVELOPED)

2.7 ETHERNET MEDIA CONVERTER

A. The Media Converter shall meet or exceed the following specifications:

1. Copper Port: 1 x 10/100BaseT (RJ45)
2. Fiber Port: 1 x 100FX Single mode fiber (SC)
3. Power Input: 120VAC

2.8 SPARE PARTS

A. The Contractor shall supply the following spare parts upon completion of the project:

1. One (1) IP CCTV Camera
2. One (1) Ethernet Media Converter
3. Three (3) Disk Drives for NVR

4. Five (5) fuses of each size used per enclosure.

PART 3 EXECUTION

3.1 INSTALLATION

A. The Contractor shall provide station reviews to determine the appropriate equipment is installed. The station review shall also include.

B. Furnish and install all material and equipment to form a complete and operational Transmission Network as specified within these documents and shown on Contract Drawings, in accordance with all manufacturers' instructions, and in compliance with National Electric Code standards, EIAITIA standards, and all applicable Commonwealth of Massachusetts local codes and ordinances.

C. Affix permanent tags at both ends of connectorized cables designating cable function, piece of equipment connected to, and receptacle designation.

D. Install all wiring in rigid steel conduit where required.

E. Identify all conductors by color code and listing its function.

F. The Contractor shall coordinate, schedule, and obtain all required system connection and testing with the operating railroads Communication Department.

G. The Contractor must complete identification of all devices before final inspection and acceptance.

H. The Contractor is responsible for all vendor coordination to ensure that proper service is provided.

3.2 SYSTEM CONFIGURATION AND ACCEPTANCE

A. Prior to system acceptance, furnish a complete set of as built drawings and documentation to include the following:

1. Line drawings of all installed equipment in AutoCAD format.
2. Step by step installation checklist specifying cabling runs and applicable installation tests.
3. System interconnection instructions.
4. Equipment provisioning for each site.
5. Acceptance test procedures.
6. Documentation and acceptance test procedures for network management system.

3.3 FIELD TESTING

A. Furnish all test equipment required and perform all necessary tests to ensure all components of the Transmission Network are functioning properly in accordance with the intent of this Specification.

B. Each device shall be tested in the presence of the Contractor and the operating railroads Telecommunication Department. Upon completion of the test, a certified test report shall be submitted for approval.

C. Any system deficiencies observed under testing shall be noted in the certified test report. All deficiencies shall be corrected and system shall be retested. A subsequent certified test report shall be submitted.

D. Test complete system with the Authority as required. If any deficiencies are observed, correct same as described herein. Contractor shall submit as built drawings and maintenance manuals and spare parts one week prior to final scheduled testing by the Authority.

PART 4 MEASUREMENTAND PAYMENT

4.2 GENERAL

A. Separate measurement and payment will not be made for the work of this Section complete in place, but all costs therefore shall be included in the Contract Lump Sum Price for the work as indicated herein.

4.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
1659.001	CLOSED CIRCUIT TELEVISION SYSTEM	LS

END OF SECTION